Moody's Analytics

RISK PERSPECTIVES

STRESS TESTING: NORTH AMERICAN EDITION

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FROM THE EDITOR

Welcome to the second edition of Risk Perspectives™, a Moody's Analytics publication created for risk-aware professionals. This compilation presents a wide range of views and approaches to stress testing, all with one larger goal in mind – to deliver essential insight to the global financial markets. The intention is to familiarize practitioners with the necessary means to turn insight into action, whether to maintain regulatory compliance, make smarter, risk-aware decisions, or enhance business planning.

While our last edition was more focused on Europe, our second edition will concentrate on the North American market – specifically how financial institutions can leverage the regulations to add value to their business, for regulatory compliance and beyond. Stress tests are now an important component of the supervisory toolbox and are therefore here to stay and evolve. Understanding the key drivers behind the new regulatory framework, and benefiting from the experience curve drawn from various geographies and practical cases, should help financial institutions to properly assess how they will cope with this new context, for both short and long-term horizons.

Given the current market conditions and regulatory pressure, it helps to have a variety of tools and guides to navigate the new terrain. *Risk Perspectives* offers actionable information and best practices to assist financial professionals with compliance, data management, and infrastructure.

In the *Rethinking Stress Testing* section, we discuss how banks can view stress testing in a new light in order to fully benefit from their enterprise risk investment. For instance, in the article "Modeling Credit Losses to Meet Stress Testing Requirements," Anna Krayn and Thomas Day examine the different approaches to meeting stress testing objectives and build a case for a unified approach.

In *Regulatory Spotlight*, we take a fresh look at the underlying causes and lessons learned so far from the various stress testing exercises, provide an update on regulations, and address how banks can handle key regulatory compliance challenges. We evaluate the "2013 Mid-Cycle Stress Test Disclosures" and their impact on banks' organizations and discuss the impact of liquidity stress testing programs in "Liquidity Risk Management is a Game Changer."

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.

In the *Principles and Practices* section, we highlight effective practices for applying stress testing to your organization and ways to deal with common pitfalls, such as gathering sufficient data or designing meaningful scenarios. In the "A Singular Approach to Applying DFAST and CCAR Scenarios Across Asset Classes" article, we study the challenges of stress testing structured finance portfolios.

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 issues of *Risk Perspectives* by sharing your feedback and comments on the articles presented in this issue.

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RISK PERSPECTIVES

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STRESS TESTING BY THE NUMBERS

$213bn

During the MCST, aggregate industry losses were posted at $213 billion, with provisions of $269 billion to cover the losses.

2013 Mid-Cycle Stress Test Disclosures.
Page 28

102%

Increase in weighted average Tier 1 common equity ratio for CCAR 2013 institutions since the end of 2008.[1]

12

Number of bank holding companies added to CCAR 2014.[2]

70%

For the Federal Reserve scenarios, the senior RMBS notes would lose, on average, about 35%, while the mezzanine notes would lose around 70%.

A Singular Approach to Applying DFAST and CCAR Scenarios Across Asset Classes (Residential Mortgages).
Page 88

90+

Number of CCAR FR Y-14 reports.

Regulatory and Management Reporting Best Practices.
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100%

Minimum ratio of liquidity coverage that institutions should continuously meet, as required by regulatory standards.

Liquidity Risk Management is a Game Changer.
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1 Board of Governors of the Federal Reserve System, *Comprehensive Capital Analysis and Review 2013: Assessment Framework and Results,* March 2013.

2 Board of Governors of the Federal Reserve System, *Capital Planning at Large Bank Holding Companies: Supervisory Expectations and Range of Current Practice,* August 2013.

3 Board of Governors of the Federal Reserve System, *Capital Planning at Large Bank Holding Companies: Supervisory Expectations and Range of Current Practice,* August 2013.

4 Board of Governors of the Federal Reserve System, *Comprehensive Capital Analysis and Review 2013: Assessment Framework and Results,* March 2013.

35.9%

Percentage of $213 billion in aggregate industry losses contributed by credit cards during the MCST.

2013 Mid-Cycle Stress Test Disclosures.
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60-70%

In commercial real estate and mortgage portfolios, often only 60-70% of the losses are realized as charge-offs in the first four quarters.

Stress Testing – a Return to RAP vs. GAAP?
Page 44

7

Principles of an effective capital adequacy process, as defined by the Federal Reserve.[3]

2-to-1

To this day, total mortgage delinquency exceeds auto and credit card delinquency by almost 2-to-1.

Modeling the Entire Balance Sheet of a Bank.
Page 62

100+

Number of people involved in the regulatory stress test exercises reported by some banks.

Leveraging the Regulatory Stress Tests to Build Long-Term Value.
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78%

Percentage of CCAR 2013 institutions receiving an unconditional "Non-objection" to their capital plan from the Federal Reserve.[4]

RETHINKING STRESS TESTING

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

IS NOW THE TIME FOR TOUGH STRESS TESTS?

By Dr. Tony Hughes

Dr. Tony Hughes
Managing Director of Credit Analytics

Tony manages Moody's Analytics credit analysis consulting projects for global lending institutions. An expert applied econometrician, he has helped develop approaches to stress testing and loss forecasting in retail, C&I, and CRE portfolios.

The banking industry needs a regulatory framework that is carefully designed to maximize economic outcomes, both in terms of stability and growth, rather than one dictated by past banking sector excesses.

Many people – with a great deal of justification – want a pound of flesh extracted from the banking industry. The notion that big banks enjoy the fruits of the upside, while socializing downside risk, is compelling and highly damaging to economic development. The stress testing framework developed by the Federal Reserve (the Fed) since the Great Recession, known as the Comprehensive Capital Analysis and Review (CCAR), goes a long way toward addressing the incentives of the banking industry. The Fed will not be able to miss future lending bubbles given the data collected in CCAR, and banks should be well capitalized on the eve of the next financial crisis.

The Fed's approach to capital adequacy assessment

The recent round of CCAR highlighted the fact that the Fed is taking a very conservative approach to capital adequacy assessment. All banks were projected to have much higher losses than suggested by internal estimates under the rather severe economic scenarios used in CCAR. Many individual credit product loss forecasts were also high, implying that the Fed is trying to discourage banks from allocating capital to those sectors. If a bank has to quarantine a lot of cash to cover, say, a new mortgage or small business loan, it increases the cost to the bank and thus the interest rate at which the loan is offered.

Tough stress tests in a normal economic environment

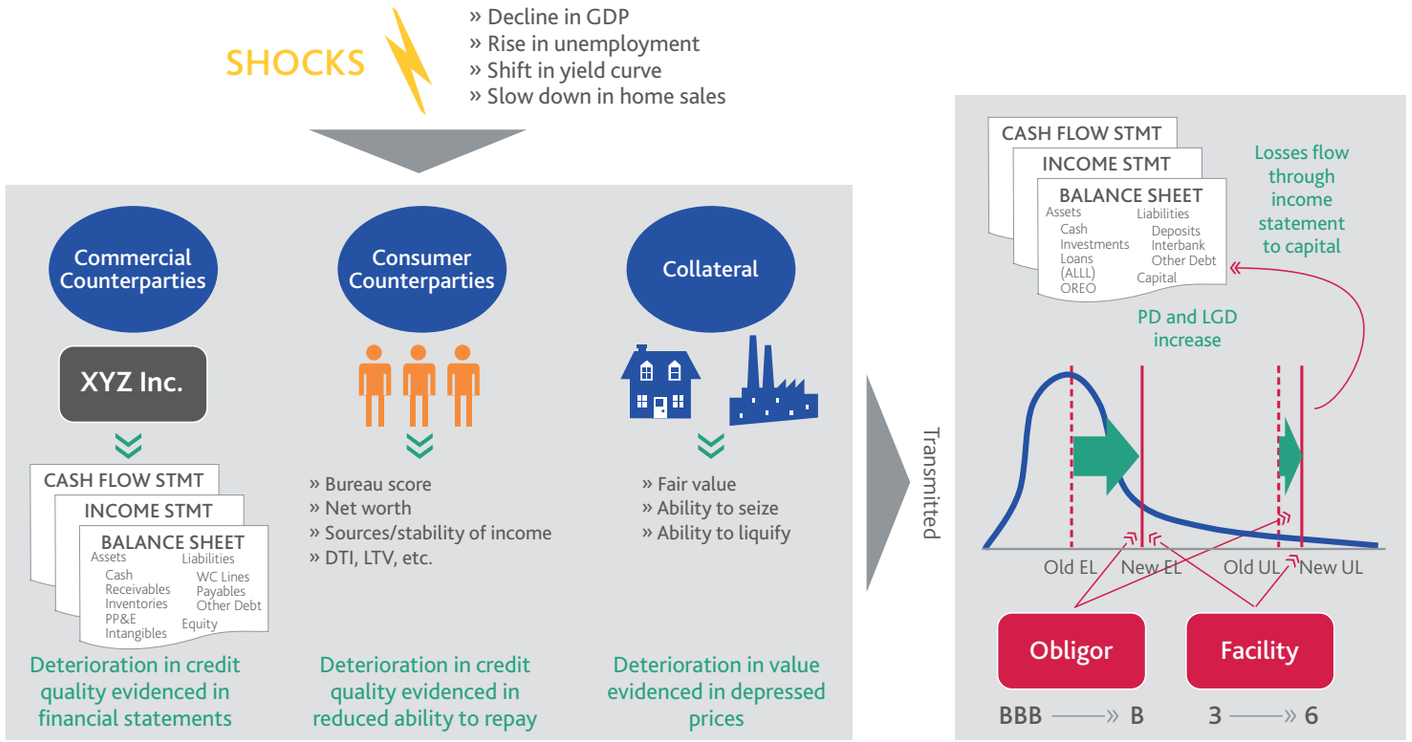
In a normal economic environment, an overly tough stress test poses few problems for policymakers. If excessive bank reserve requirements were having an undue effect on economic growth, and if rates were clearly positive and stable, the Fed could respond by simply reducing the headline federal funds interest rate. Big banks would still be forced to meet strict capital requirements. Small lenders, those not deemed "too big to fail" and thus not subject to the increased scrutiny of stress testing, would see cost structures fall and profits and market share rise.

The current economic reality

The current economic situation is rather different. The federal funds rate is effectively zero, inflation is tame and falling, and unemployment is unacceptably high. The Fed Chairman, Ben Bernanke, has been forced to massage inflationary expectations and use unconventional monetary policies like quantitative easing (QE) to keep the economy growing. In such circumstances, policy shifts cannot easily be used to counter the effect of economic shocks, one example being an overly

The recent round of CCAR highlighted the fact that the Fed is taking a very conservative approach to capital adequacy assessment.

Figure 1 Stress testing focus: assessing shocks and how they transmit



Source: Moody's Analytics

strict stress test. Given that the purpose of QE is to reduce interest rates and encourage bank lending, having the stress testing arm of the Fed discourage lending is completely anathema. At the moment, the Fed is both for and against accelerated loan growth. Figure 1 outlines how stress testing addresses shocks and their impact on the bank.

Sparing the nose

In the short term, the Fed should tone down or even reverse the rank conservatism of the CCAR. This may be galling to taxpayers still angry about bailing out big banks during the financial crisis; it is, though, better to spare the nose even if it means the face goes spite free. When the economy is truly recovered – hopefully soon – the flesh can be extracted from the banks without worsening the plight of the unemployed and others desperate for normal economic service to resume.

Appetite for bank destruction

In the long term, a discussion about society's appetite for bank failure risk should take place. A world where bank failures are rendered impossible due to strict capital standards is not optimal, nor is a world where big banks line up for bailouts within months of posting record profits. The economy grows fastest and most assuredly when banks take sensible risks in extending credit to potentially profitable businesses and seemingly creditworthy individuals. In an ideal model, bank failures, even big ones, will still occasionally occur.

The bottom line

We need a regulatory framework that is carefully designed to maximize economic outcomes, both in terms of stability and growth. Such an outcome is impossible if we let our malice over past banking sector excesses dictate future policy development.

MODELING CREDIT LOSSES TO MEET STRESS TESTING REQUIREMENTS

By Anna Krayn and Thomas Day

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This article discusses two conceptual approaches for modeling stressed credit losses: top-down and bottom-up. It highlights the benefits and challenges of using each approach and regulatory expectations.

As stress testing requirements in the US mature and the next "batch" of institutions begin to comply with Dodd-Frank Act Stress Testing requirements, methodologies for loss estimation will continue to evolve. While standards of practice are beginning to form, guidance on methodological and modeling approaches to date is creating confusion. It is also causing a divergence of practices and a variety of modeling approaches among financial institutions – the benefits and pitfalls of each are widely debated.

Often lost in the discussion is that the Interagency Guidance on Stress Testing (SR 12-7) suggests multiple approaches to properly manage and control model risk: "an effective stress testing framework employs multiple conceptually sound stress testing activities and approaches." This guidance applies across the capital planning process, including credit loss estimation, liabilities, new business volumes, and pro-forma balance sheet and income statements. This article focuses on two conceptual approaches for modeling stressed credit losses: top-down and bottom-up.

> "…an effective stress testing framework employs multiple conceptually sound stress testing activities and approaches." (Interagency Guidance on Stress Testing – SR 12-7)

A top-down modeling approach

In top-down modeling, exposures are treated as pools with homogeneous characteristics. Scenarios (i.e., macroeconomic or idiosyncratic event-driven) are correlated to historical portfolio experiences. Examples of such approaches include transition matrices, roll-rate models, and vintage loss models. The outputs from this approach are intuitive and easily understood outside of the credit risk function and can be readily calibrated and back-tested against ongoing actual and projected performance. This is increasingly important, as stress testing and capital planning requirements are forcing stress testing analytics to be coordinated among the treasury, finance, and risk groups. Such top-down approaches can also be easier to develop as pool modeling is not exposed to the idiosyncrasies or noise of modeling single firm financial statements. Additionally, historical data is readily available at most institutions, as the same type of data is needed for modeling allowances for loan losses. A bank's own loss experience can, therefore, be incorporated into the analysis, satisfying an element of the "use-test" criteria for model validation.

Top-down modeling has been widely adopted for some retail portfolios as both champion and challenger models, where homogeneous groupings are more easily identifiable. At the same time, this approach can ignore important risk contributors and nuances for more heterogeneous portfolios (e.g., commercial real estate, commercial and industrial loans, project finance, and municipal exposures). For these portfolios, top-down models serve better as a secondary or "challenger" modeling approach, rather than a firm's primary modeling methodology.

A bottom-up modeling approach

Bottom-up modeling refers to counterparty or borrower-level analyses. Typically, the risk drivers for a specific segment or industry are correlated to macroeconomic variables. Granular, borrower-level analysis goes beyond regulatory-mandated stress testing and can serve as a foundation for risk-based pricing, improved budgeting and planning, economic capital modeling, and limit- and risk-appetite setting. It can also highlight the most desirable banking relationships while isolating the riskiest relationships and concentrations.

Methodologically, there are several approaches to bottom-up modeling. Many banks use actuarial modeling to determine credit risk transition, delinquency, and default, as well as loss frequency and magnitude. However, they often miss critical factors such as the timing of delinquency, default, and losses, which require cash flow based approaches. One major challenge is that many organizations do not possess the required data necessary to calibrate credit-adjusted, cash flow models. Few institutions have systemically collected borrower-level financial statements and default and loss data over several business cycles. Many treasury and asset-liability committee (ALCO) members, however, prefer to think of balance sheet risk in a cash flow (i.e., option-adjusted) fashion. As a result, many organizations are required to supplement internal modeling with external data, modeling, and model calibration techniques from third parties, leading to longer development cycles.

Bottom-up modeling for stress testing will soon be applied to Basel III, potentially making it the preferred methodology in the long-term. For bank officers embarking on developing a stress testing program who are less familiar with data and risk quantification requirements associated with bottom-up modeling, development, and firm-wide adoption of obligor-level analysis may require additional time and cross-organizational buy-in. While rapid implementation timelines driven by regulation, flexibility, and intuitiveness of the approach may make top-down modeling more attractive in the short-term for many banks, it is equally important to ensure a firm's modeling architecture is designed to be leveraged and reused once they are ready to graduate to a more comprehensive and holistic bottom-up modeling approach.

While expediency to meet requirements is critical, it is equally important to ensure the firm's modeling architecture is designed to be leveraged and re-used once the firm is ready to graduate to a more comprehensive and holistic approach.

Using multiple approaches

While no single modeling approach has been blessed by the regulatory agencies or emerged as a best practice, two things have become clear. First, the use of multiple, conceptually sound approaches is prudent given the imprecision of existing "state-of-the-art" modeling techniques. And second, selected developmental data samples should have sufficient granularity and robust timelines appropriate for the portfolio being modeled.

INTEGRATED RISK MANAGEMENT: OVERCOMING BANK SILOS TO OPTIMIZE STRESS TESTING

By Nicolas Kunghehian

Nicolas Kunghehian
Director, Business Development

Nicolas provides insight 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, realizing there were significant losses, decided to jettison these increasingly risky securitized 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 realized that it was necessary to take a risk inventory and analyze 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 realizing that their legacy organization structures need to be closely revisited and some enduring organizational walls will need to come down – either physically or logically.

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.

LINKING DIFFERENT TYPES OF RISKS

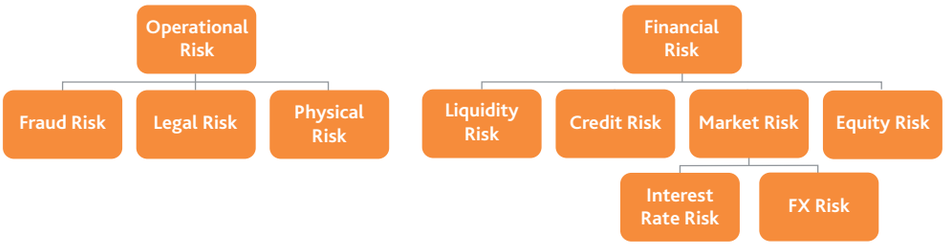
Mapping all the risks that banks face would create an extremely long list. Instead, this article provides examples of the links between some of the most important risks found in banks.

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 banks continue to face."* [1]

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

Figure 1 Different types of risks



Source: Moody's Analytics

for a treasurer to find cash in the very liquid 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.[2]

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

Asset and liability management (ALM) teams have always worked on interest rate risk and liquidity risk. Basically, the maturity mismatch between assets and liabilities could be analyzed 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 behavioral option (e.g., a 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.

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 behavior 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.

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

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 US dollars or euros 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.[3]

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 modeled 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.

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

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."* [4]

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. More and more people in the banking industry, however, realize that, as Gillian Tett of the Financial Times says: "there was a problem of silos, or fragmentation, both in a structural and cognitive sense, which made it hard for both insiders and outsiders alike to take a holistic vision of how credit was developing." [5]

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 with the Comprehensive Capital Analysis and Review (CCAR) and Dodd-Frank Act Stress Test (DFAST). 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 analyze 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, while 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.

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 categorize a risk as FX while the market risk team could say that it is credit risk.

This example 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. It 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.

Even in a treasury, some banks see a strong opportunity to improve their profitability, as Jennifer Boussuge, Head of Global Treasury Sales, Bank of America Merrill Lynch, says: "One of the biggest hurdles in optimizing working capital is that responsibility for the various elements in the working capital cycle, such as purchasing, treasury, sales, accounts payable, and accounts receivable, are separate functions with different management structures, objectives, and key performance indicators (KPIs)."[6]

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 are in the eyes of a business area and senior management."*[4]

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 "gaps."

Sharing information and having a common framework fosters communication across an entire organization, 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 recognize 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."[4]

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 modeling 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.).[7]

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:

I. If one of a bank's counterparties defaults, the bank will stop lending to that counterparty

II. If the equity prices drop below a given limit, the bank will reduce their exposure to the equity market

III. 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."[4]

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 organized 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 realizes 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 organization 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 recognize the benefits of integrating risk. For example, they do not want to discover that their institution became bankrupt overnight because the balance sheet of a subsidiary abroad was insufficiently analyzed. These stakeholders 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 should not try to create an ultimate model that will never be realized. 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. Senior management will better understand all the options for defining their strategy and the risk appetite of their financial institution; thus increasing the long-term profitability of shareholders.

The benefits of a stress testing platform

If a platform for integrated risk management provides many benefits for banks, what are the key points for successfully organizing a stress testing platform?

First of all, data management is crucial. Building a robust and consistent data warehouse, however, is a difficult task – especially when multiple teams are involved. There is always one team that seems to be less concerned by such a big project. Some treasury departments may see a data warehouse as a burden and with no added value for their day-to-day job. Experience shows that, for this reason, the CFO should be designated as the project manager. Leading the project provides an opportunity for the CFO to add features that will benefit his or her team. The data warehouse will then become a real risk and finance project.

The other important task consists of convincing the different stakeholders that a stress testing framework will tackle not only adverse effects, but also upside effects. Viewing risk management as an opportunity to improve business is a cultural shift in most banks. Risk departments will then be able to deliver more insight and discover more opportunities. Many business lines will then see the risk department as an ally, rather than a pessimistic risk controller.

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3. Morrison, S., Barrie & Hibbert, *Aggregation of Market and Credit Risk Capital Requirements via Integrated Scenarios*, 2013.
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LEVERAGING THE REGULATORY STRESS TESTS TO BUILD LONG-TERM VALUE

By Dr. Christian Thun

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Banks have to dedicate enormous resources to comply with CCAR and DFAST, but rather than treating stress testing like a check-the-box exercise, banks should view it as an opportunity to better manage their businesses and invest in robust stress testing frameworks.

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. Regulatory compliance is challenging, however, there are ways in which banks can use the exercise to build long-term value, beyond meeting the Comprehensive Capital Analysis and Review (CCAR) and Dodd-Frank Act Stress Test (DFAST) requirements. This article addresses the multiple thorny issues that banks face when complying with the regulations and provides solutions about how to develop a framework that accommodates the demands of both regulatory and business-driven stress testing.

Stress testing – a regulatory response to the financial 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 the verge of collapse caused 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 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.

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.

Banks face enormous challenges

These regulatory requirements represented huge challenges – the amount of information that was requested, ill-defined regulatory requirements, siloed architectures, and fragmented risk management approaches – in many banks and caused inconsistencies, duplicate work, incomplete aggregations, and concerns about

the reliability of the overall results. Specific concerns that needed to be addressed, in many cases for the first time, were:

- Stress testing requires extensive data gathering, organization, validation, and often manipulation prior to input into the CCAR model
- Frameworks, applications, and processes have to be developed to support CCAR reporting on a regular basis
- The quality of stress testing output is dependent upon the quality of input – data input and quality control processes are essential to effective stress testing

The resources had to be allocated to perform the calculations and – most importantly – meet the deadlines set by the regulators, greatly exceeding 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.

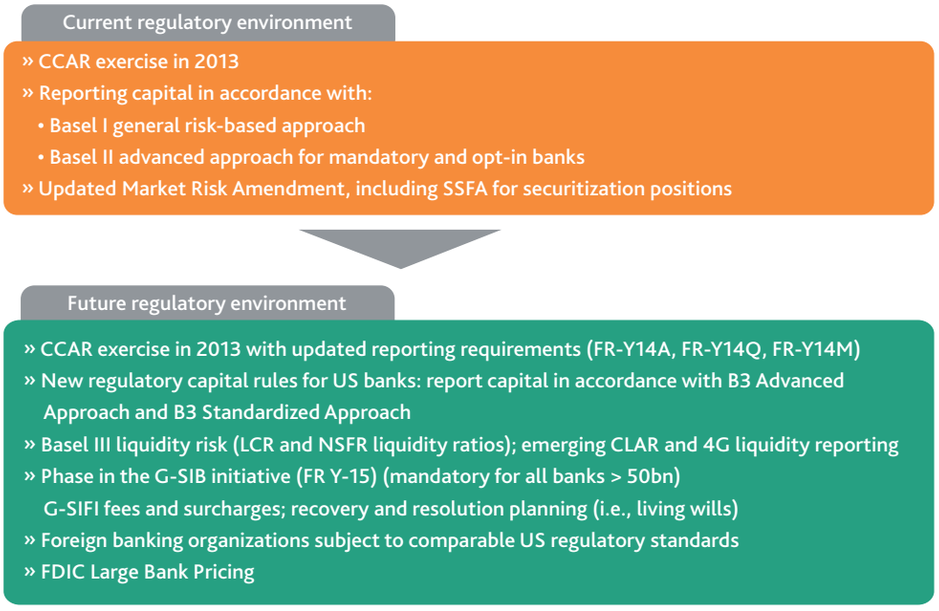
The complexity of the requirements will only increase

The stress testing exercises required by the Federal Reserve (the Fed) are expected to increase in complexity over time (Figure 1). 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 their ability to think creatively about their own business 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?

The stress tests are valuable

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

Figure 1 The regulatory environment is expected to increase in complexity



Source: The Federal Reserve[1] and Moody's Analytics

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 materializes.

With this in mind, the regulatory stress tests positively impacted the risk management cultures of many banks. Still, many organizations consider regulatory stress testing more of a burden than an opportunity to learn and improve their internal processes.

Redefining a stress testing approach

As banks adopt and support regulatory stress testing exercises, the benefits of aligning their business needs with regulatory requirements become clear. With validation of forward-looking, scenario-based forecasts becoming an increasingly recognized sign of organizational and managerial strength, many banks are taking the new requirements seriously and reimagining their existing processes and risk analytics. To be sure, the complexity of the new stress testing and capital planning requirements is daunting and requires a commitment from senior leadership.

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.

This will require tremendous organizational changes, as these stress testing exercises will involve the risk management, treasury, and capital planning departments. One solution is for banks to have a dedicated department working on stress testing, which could then challenge the risk departments on their systems and models. This stress testing department could effectively act as an independent check.

Areas to address

Some banks still have to address what they see as the most difficult steps in developing quality stress tests:

1. **Sourcing and managing appropriate data:** Financial institutions need to source, aggregate, and consolidate all the data necessary to understand and properly model behavior under stress, and meet reporting requirements. Legacy systems and silos hinder the flexibility required for efficient bank-wide or cross-risk stress testing, as well as its planning and coordination.
2. **Modeling scenario impact on risk parameters:** Supervisors will increasingly challenge internal models, so banks will need to accurately calculate the impact of macroeconomic, event-driven, and institution-specific scenarios to estimate losses across key risks (credit, liquidity, market, etc.) and asset classes. The estimation of the impact stress scenarios have on a bank's cash flows and P&L is of particular interest to senior management as it directly links stress testing to performance.
3. **Efficiently reporting the results:** Due to the growing complexity and number of regulatory stress testing requirements, reporting stress testing results has become a time-consuming activity. Banks need efficient reporting tools that enable them to respond quickly to evolving regulatory requirements and can be leveraged for business purposes.
4. **Automating the stress testing process:** Banks need an automated process that aggregates data points from multiple loss estimation models, matches balance sheet and income statement dependencies, and ensures consistent, integrated forecasting of all income statement and balance sheet categories.

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 implemented, 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.

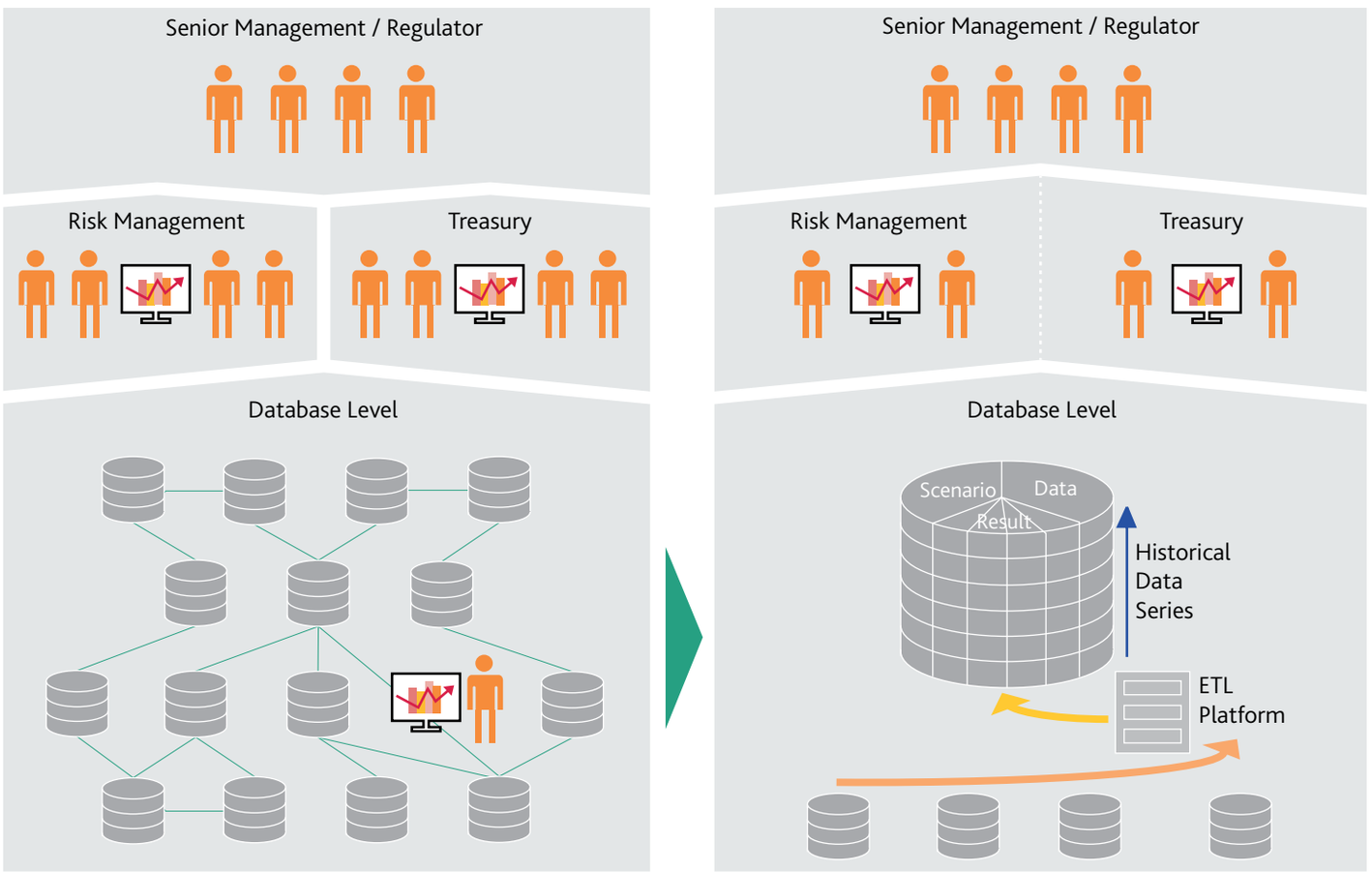
Comparing stress testing processes

Figure 2 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

The process illustrated in Figure 2 can be currently observed in many banks trying to respond to regulatory (or senior management) 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

Figure 2 Comparison of a typical versus a leaner, more efficient stress testing process



Source: Moody's Analytics

system is inefficient and costly. Perhaps even more disturbing is the inherent high risk of error prevalent in this ungainly process.

A leaner, more efficient stress test process

Banks will not be able to avoid the burden of regulatory stress tests, so 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 right side of Figure 2 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 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.

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

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.

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

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REGULATORY SPOTLIGHT

Addresses the lessons learned from the stress tests and how upcoming regulatory updates will impact banks.

2013 MID-CYCLE STRESS TEST DISCLOSURES

By Thomas Day
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This article provides a summary of the mid-cycle stress test results, including observations about scenarios, loss estimates and PPNR, disclosures, and areas for improvement.

In September 2013, the 18 Comprehensive Capital Assessment and Review (CCAR) banks released, for the first time, their mid-cycle stress test (MCST) results.[1] The MCST differs in significant ways from the annual Federal Reserve (the Fed) CCAR and Capital Planning Review. In particular, firms are responsible for creating their own macroeconomic scenarios and may, in some cases, use models and approaches that are different from the CCAR modeling exercise. The capital actions permitted by the Federal Reserve are certainly different than those for the CCAR exercise, and firms have more discretion with planning and taking management actions throughout the forecast horizon. Importantly, the Fed will not provide an objection, conditional approval, or non-objection to the mid-cycle results, at least not publicly.

The objective for the MCST is to allow firms to better tailor scenarios to their own idiosyncratic risks. The CCAR exercise is a "one size fits all" test that is specified by the supervisory agencies, which does not permit differentiation across business models – differences that may be critical to loss, revenue, provision, and capital calculations.

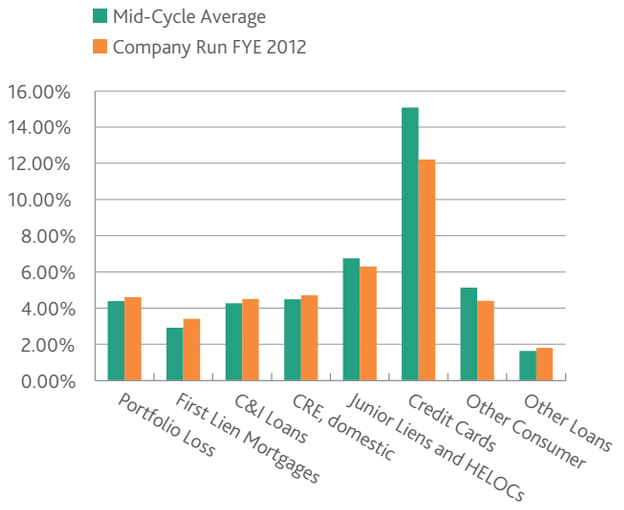
Scenarios

The recent MCST results have yielded interesting observations. In aggregate, the overall severity of the scenarios used by the banks largely matched the stresses from the Federal Reserve System's (FRS) CCAR exercise. The banks generally took a conservative approach to the stress scenarios, although there were a few whose scenario assumptions seemed far less severe than anticipated, as indicated by peer comparisons and other stressed economic variables provided by economic research firms. This fact may signal that some banks should better assess their scenario assumptions and compare them to other available scenario sets.

The approximate average of the unemployment rate used in the scenario was 12.12%, whereas one firm's peak unemployment level was only 10.9%.[2] The peak unemployment in the FRS 2013 CCAR exercise was around 12.1%. The impact to GDP was uneven across the MCST disclosures, with a range of peak GDP declines in the forecast from -1.1% to -8%. The peak GDP decline in the FRS scenarios was -6.1%, and the average peak rate across all MCST results was approximately -4.76%, not nearly as severe on average as the Fed scenario. The peak-to-trough House Price Index (HPI) decline from the last FRS scenario was approximately -20%, and the MCST average decline was -22%, with one firm estimating a -43% decline in home prices. Interestingly, the Fed uses the Dow Jones but virtually all of the MCST reporting banks chose to use the broader S&P 500. In the last CCAR round, the Fed scenario posted an approximate -24% decline in the Dow Jones, whereas the average for the banks reporting a severely adverse S&P 500 shock was on average -44%.

The most interesting observation was the use of tailored idiosyncratic scenarios by the banks, an

Figure 1 Mid-Cycle Loss Rates vs. FYE 2012



Source: Moody's Analytics

expectation clearly articulated by the FRS. Ally used a massive oil price shock (a peak oil price of $229), as well as a used car after market index shock (the Manheim Index), to tailor the stress test and models to their particular business models. In other cases, like US Bancorp, Fifth Third Bank and KeyCorp, the scenarios were connected with their geographic footprint to account for the regional portfolio concentrations of their credit portfolios. Goldman Sachs included a reputational risk event in their stress test, and one bank – Bank of New York – considered how stresses are transmitted across various risks (i.e., how credit may impact liquidity, market, and operational risks). This is a sound practice given that the interaction across financial risks is a significant contributor to assessing a firm's overall resiliency.

Loss estimates and pre-provision net revenue

While comparing loss rates from the 2013 CCAR exercise to the MCST disclosures is at best an "apples and oranges" comparison, the overall loss rates disclosed in the MCST are an improvement over the 2013 CCAR results. Figure 1 provides a summary of all the reporting banks.[3] All asset classes showed a reduction in overall loss estimates, other than Junior Liens, Credit Cards, and Other Consumer.

Aggregate industry losses were posted at $213 billion, with provisions of $269 billion to cover the losses. The 2012 and 2013 aggregate losses were estimated at $534 and $462 billion, respectively, with provisions of $324 and $317 billion. Across the planning horizon, no bank came close to breaching the FRB's 5% Tier 1 common threshold, with a minimum of 6% (Ally) and a maximum of 12.3% (State Street). In fact, five of the reporting banks showed a beginning-to-end increase or no change in Tier 1 common capital, with the average decline in total risk-based capital being only -2.71% and Tier 1 common of -4.54%, with an aggregate average total and Tier 1 common of 13.53% and 9.32%, respectively. Eight banks actually increased the total risk-based ratio, reflecting lower balances and a shift to less risky assets. The leverage ratio decline was -3.18%. Credit cards were the largest contributor to consolidated losses, with 35.9% of the total loss contribution across the industry (see Table 1).

Pre-provision net revenue was $315 billion, offset by the aforementioned provision level of $269 billion, trading losses (subject to instantaneous shocks of the global market) of $74 billion, securities losses of $7.7 billion, and other losses of $17.7 billion. These losses were commonly related to goodwill, deferred tax assets (DTA), intangibles, for valuation only (FVO) changes, or related impairments and/or legal reserve builds and expenses.

Disclosure components

The various management planning actions were some of the more compelling components of the MCST. For example, some banks thoughtfully adjusted new business volumes in the scenarios to account for lower credit demand and availability. These banks used internal or vendor-supplied loan demand models by asset class. While few banks mentioned the use of sophisticated supply models for credit, some banks did vaguely describe the use of statistical models, combined with historical industry and internal data, to attempt to measure the appropriate rates and spreads associated with the available asset class credit demand.

This is an interesting approach in that as a bank adjusts its rates and spreads, the level of "received" new volumes declines, reflecting a conscious risk appetite decision by the bank's planners. Higher relative rates and new business credit spreads in the pro-forma plan would naturally imply a lower supply of credit and a tightening of implied credit standards under the scenario, while lower relative rates and spreads might imply a greater supply of available credit. In many cases, this is done qualitatively through interactions between the finance, risk, and lines of business, although quantitative conditional rate and spread models are sometimes used. Given the new Federal Reserve guidance on the incorporation of Basel III capital rules into the CCAR forecast,banks may need to revisit these simple approaches that merely follow Basel I rules, holding risk-weighted asset (RWA) levels constant across the planning horizon.[4] This incorporation of Basel III rules should result in more granular and accurate modeling of credit conditioned new business volumes, and increase the communication and interaction between internal functional groups and the risk origination business lines of the bank.

It is clear through the disclosures that many of the banks are also having difficulty measuring, in a quantitatively sound manner, non-interest revenue and non-interest expenses. This is a challenging exercise, as a bottom-up approach relies on measures of business activity, headcount, loan balances, pipeline, service metrics, asset balances and flows, account balances, and other measures that may not be easy to obtain; or if obtained, the underlying quality of the data may be suspect. As a result, many banks are estimating the numbers at the line of business (LOB) level with workbooks and policy guidance provided by the firm's central stress testing function. The LOBs are working with the firm's quantitative modeling and finance groups to build appropriate statistical and planning models. Some banks are supplementing this approach with third-party analytical models, using available public Call Report, FR Y-9C, and firm-specific data. Such modeling, consistent with the Federal Reserve's approaches, allows for a champion/challenger approach to this somewhat opaque area. Using alternative approaches is fully consistent with

Table 1 Consolidated losses by asset type

Asset Type	Losses (in Billions)	Percentage
Credit Card	$76.5	35.9%
C&I	$31.5	14.8%
First Lien Mortgages	$29.0	13.6%
Junior Liens	$27.9	13.1%
Other Consumer	$20.2	9.4%
CRE	$18.0	8.4%
Other Loans	$10.2	3.8%
Total	$213.2	

regulatory guidance[5] and may assist banks in the sensitivity analysis or results, a key area of focus of the supervisory agencies, as evidenced by recent studies.[6]

Lastly, it was interesting to see how critical technical areas were addressed in the stress tests. For example, the modeling of disallowed deferred tax assets was critical in several cases to capital results, as was the need to consider the buildup of legal reserves to cover expected future claims, such as representations and warranty claims with government-sponsored enterprises (GSEs). Capital One's criticism of the lack of transparency around the FRS' models and methods, and that "…the Federal Reserve appears to have made a philosophical choice to use industry-wide models without making adjustments for objectively observable business practices and results among banks"[7] seems like a well-phrased consensus statement underpinning many of the disclosures and conversations throughout a majority of the MCST filings. While the supervisory agencies are sensitive to the expectation that the banks should not strive to mimic the Fed models, additional transparency and industry dialogue regarding sound and better practices seems reasonable, and should be routine, and be a more transparent element of this ongoing exercise. Many firms believe more transparency and openness would increase the effectiveness of industry sound practice evolution, as well as accelerate the creation of improved standards of practice.

Disclosure scorecard

As a part of our review of the disclosures, we developed a scorecard, based on a qualitative assessment of the MCST disclosures, scoring each firm across several dimensions of reporting detail. While we do not present firm-level scores, we believe Table 2 provides an indicative measure of overall quality.

This qualitative score emphasizes that the overall adequacy of the disclosures can be improved, with immediate attention focused on how the entire MCST, and the CCAR itself for that matter, is governed. It is clear many banks are only accommodating the minimum disclosure requirements. While there seems to be no market interest or reaction to the disclosures, an enriched narrative that expands the depth of the analysis and a more effective discussion around modeling methods, as well as how the systems, models, and methods are used within a firm (not necessarily the stress metrics), will go a long way toward enhancing the process.

It is also helpful to note that the range of expected disclosures may have been over-specified. It may make more sense to mandate a certain minimum set of disclosures, but provide more guidance and principles around enhanced prudential expectations, and make internal adjustments to the process to encourage banks to meet more than the minimum standards. Expectations might address the depth of analysis, the incorporation of a broader range of metrics (such as operational risk, liquidity, investment portfolio losses, and mark-to-market losses), and key operational challenges. They also might focus on significantly improving management discussions and analysis about

Table 2 Disclosure scorecard

	Disclosure Detail	Scenario Detail	Depth of Analysis	Metrics Covered (Reporting)	Governance Discussion	Methodology Discussion
Aggregate Score	2.22	2.28	1.94	2.00	1.83	1.78

Good	3
Average	2
Improvement Needed	1

governance and how the overall program is expected to evolve to become more practical at enhancing internal risk management, planning, internal capital adequacy assessment process (ICAAP), and risk-based pricing initiatives.

Observed areas for potential improvement

It is important to note that the overall utility of the stress test reports may need to be revisited. One of the gross assumptions of the entire CCAR and MCST exercises is the exclusion of liquidity impacts and measures, as well as the failure to consider systemic transmission and contagion effects across capital, funding, payment systems, and markets. Internally, only one bank considered transmission effects across various risk pools. This seems like a reasonable risk management consideration given that severely adverse loss events will certainly have a sizable impact on liquidity, particularly wholesale funding, depletion of unencumbered liquid assets (due in part to collateral calls and derivative revaluations), and the liquidity effects of other off-balance sheet non-contractual commitments.

> Aggregate industry losses were posted at $213 billion, with provisions of $269 billion to cover the losses… the largest contributor to consolidated losses was credit cards, with 35.9% of the total loss contribution across the industry.

While all banks appear to have easily "passed" the 5% minimum Tier 1 common capital target set by the FRS, this largely ignores the potential for massive disruptions across banks, which causes each firm to "lock down" their positions, hoard liquidity, and freeze credit creation, resulting in the evaporation of liquidity buffers. Clearly, the Fed is pursuing enhanced liquidity policy through other exercises, but it may help to consider how these two highly correlated risks could be presented in a more unified analysis.[8]

While idiosyncratic scenarios are important, it remains unclear what the overall use case is for the stressed measures, other than as an "extreme event" calculation to determine firm-specific capital resiliency. Many firms appear to be struggling to determine the use case for the stressed measures. This is perhaps due to the fact that internal systems and processes across finance, risk, treasury, and trading remain focused on creating the stressed measures – rather than linking and automating the various business processes – while treating stressed measures as a "special case" of enhanced risk, finance, and balance sheet planning. Importantly, with the emerging US liquidity risk reporting requirements, the ability to measure interaction effects between liquidity, credit, and capital will likely become more important.

The highest utility of the exercise, to date, may be in increasing the communication, as well as the functional and technical integration, across various business lines, and ensuring that the same models used for stress testing are also used in day-to-day risk management. The collection and use of the underlying data for static-pool analysis and risk assessment, likewise, potentially generates medium-term positive benefits, as long as the firm has the right technical data foundation, data models, and associated platform tools to create helpful line-of-business and related risk reports. Certainly, such data will be critically important for supervisors, as it will enhance continuous off-site supervision.

The underlying data could also potentially be used to enhance recovery and resolution planning. The increased data standards may also be helpful for various M&A activities. The data collected could essentially become the functional equivalent of a firm-level "data room" available at all times, which seems like a valuable safety and soundness mission and could certainly support the FDIC's Title II Orderly Liquidation Authority (OLA) mandate. Such data might also assist in better risk-based deposit insurance pricing, and aid the Fed in discount window lending under FRA 13(3), or other crisis-based emergency lending programs.

Finally, it is a mystery that the loan and counterparty-level data standards are not being applied to the $10-50 billion banks. While the supervisory agencies are wise to consider reducing burdens on Main Street banks, more M&A activity will occur in this space than in the large bank space. Having access to common data feeds would clearly help accelerate the due diligence, bidding, and (possibly) multiples received. If the stress testing program persists – it seems like we are only in the first inning of a long ball game – better data, risk management, risk integration, and financial planning will benefit all well-run banking organizations.

over-specified and, as noted previously, if the various requirements handcuff innovation due to rules rather than principles. While standards need to be clear at the data level, similar to the Financial Products Markup Language (FpML), it may be useful to consider alternatives at the implementation and functional application layer.

Banks should change their focus to view the stress testing exercise as many had originally hoped – to create a more integrated view of forecasted risks across a more fulsome range of risk types and scenarios, with the tools and technologies that can link front, middle, back-office, risk assessment, and finance. This strategy creates a more agile, transparent, risk-aware, and efficient organization. The Federal Reserve deserves credit for undertaking such a difficult, multi-year exercise. However, developing useful tools, systems, data, and risk assessment methodologies that allow for dynamic and integrated balance sheet, income statement, cash flow, regulatory, and economic capital forecasts – which can be used every day, not simply twice a year under strict, rule-based conditions and limited scenarios – might enhance the overall utility of the large investments being made. The lack of more dynamic risk measures, methodologies, and integrated infrastructure appear to be a persistent challenge, perhaps as a direct result of possible over-specification.

While we appreciate that liquidity risk is being assessed in a separate regulatory silo, we are collectively attempting to break down silos, not build new ones.

Other areas that may be considered as areas for improvement are:

- Enhanced disclosures around sensitivity tests, using champion and challenger model results to facilitate the analysis
- Better disclosures around model performance by disclosing out-of-sample test results and similar measures, which could be added as a technical addendum
- Significant lack of discussion and disclosure around securities portfolios, including other than temporary impairment (OTTI) numbers and clear mark-to-market (MTM) in the base-case and the forecast
- Operational risk losses are buried in non-interest expense lines throughout the disclosures – this metric should be reported in more detail, with stress measures by operational risk category type
- Improved methodology disclosures and discussion; current disclosures are too high level

It seems clear that many of the CCAR and MCST banks continue to view the stress testing exercise as a chore and compliance burden, not as an exercise to improve and refresh their internal systems, business processes, and integrated risk calculation capabilities. Perhaps this is to be expected if the overall regime has become

It seems intuitive that the interaction effects between a "credit loss dominated" stress test and the transmission of such a shock, idiosyncratic or systemic, to the funding markets, particularly wholesale, should be directly incorporated into the stress testing exercise. In the MCST, it is unclear how liquidity runs and stresses are incorporated, and there was little-to-no discussion around models for assessing funding flight risk under stress. While we appreciate that liquidity risk is being assessed in a separate

regulatory silo, we are collectively attempting to break down silos, not build new ones.

The ability to create unified measures is available, but it is clearly not cheap, nor quick. The need is real, though, and the regulatory agencies recognize this fact. Banks will need to increase their investments. As an immediate area of focus, and due to the required incorporation of the Basel III framework into the projection beginning in 2014, banks will need to consider, and begin building soon, much more profound and accurate measures for planning conditional credit-adjusted new business volumes and measuring the associated risk-weighted assets (RWAs) in a dynamic and granular fashion. Blunt statistical tools, portfolio average risk ratings, and PDs/LGDs/EADs, will not (and should not) suffice. While it may take the supervisors some time to catch up to this fact, banks should begin planning now.

While we are still learning a lot through these exercises, it is clear that continued improvement in data, architecture, risk analytics, reporting, governance, and the establishment of a comprehensive set of "use cases" for the overall framework, will need to evolve. The investment in this exercise is significant. It would be a mistake if the developed data, modeling capabilities, and internal governance structures did not result in a much more effective method for enterprise-wide balance sheet, credit, financial, and liquidity risk management, rather than merely establishing a highly assumptive and error-prone assessment of capital adequacy and planning.

Ultimately, the supervisors and the banks desire to be strong credit intermediaries, while earning a reasonable return on equity. In order to achieve this objective, the investment in CCAR infrastructure should be biased towards useful business goals and objectives. This means creating a platform that allows for dynamic interaction across firm-wide risk pools, an exercise that – rather than being an annual compliance burden – should evolve into a monthly business, financial planning, balance sheet, and performance management tool.

With the issuance of FR SR 12-17, which deals with the new consolidated supervisory framework for more complex institutions, the need to focus on capital and liquidity planning, governance, and recovery planning will continue to drive the stress testing program forward.[9] As the overall project evolves, and as the industry, supervisors, and other third parties continue to learn, it is in the best interest of policy that the process moves in a constructive direction. This creates not only assessments of capital adequacy, but also a stronger, safer, and more sound financial system – one that is resilient, growing, profitable, and better informed about current and potential future risks.

1 Section 165(i)(2) of the Dodd-Frank Wall Street Reform and Consumer Protection Act and related regulations require large bank holding companies with total consolidated assets of $50 billion or more to conduct two stress tests each year. In the mid-cycle Dodd-Frank Act Stress Test (DFAST), each firm is required to conduct stress tests under a set of internally developed scenarios (baseline, adverse, severely adverse). In the annual DFAST submitted in January of each year, each firm is required to conduct stress tests under a set of scenarios (baseline, adverse, and severely adverse) developed by the Board of Governors of the Federal Reserve System (Federal Reserve).

Banks are required to submit the results of the mid-cycle DFAST to the Federal Reserve by July 5 of each year, including projections of pre-provision net revenues (PPNR), trading and counterparty losses, provision for loan and lease losses, and capital levels over a nine-quarter planning horizon (Q2 2013 to Q2 2015 for the 2013 mid-cycle DFAST) under these scenarios. Mid-cycle DFAST rules also require each firm to publish an overview and summary of results based on the severely adverse scenario.

2 Note that the scenario averages and other details are approximate given the inconsistent reporting of scenario data across the eighteen MCST banks.

3 Note that banks reporting zero losses for various asset classes were removed from the averages to avoid skewing the numbers. Also, given State Street's reduction in CRE assets from the CCAR exercise to the MCST, we removed the CCAR CRE loss numbers to better represent loss rates amongst the lenders engaging in the CRE lending business.

4 Board of Governors of the Federal Reserve System, Two interim final rules, September 24, 2013.

5 Board of Governors of the Federal Reserve System, *Supervisory Guidance on Stress Testing for Banking Organizations with More Than $10 Billion in Total Consolidated Assets, Principle 2*, May 2012. http://www.federalreserve.gov/bankinforeg/srletters/sr1207.htm

6 Board of Governors of the Federal Reserve System, *Capital Planning at Large Bank Holding Companies: Supervisory Expectations and Range of Current Practice*, August 2013. http://www.federalreserve.gov/bankinforeg/bcreg20130819a1.pdf

7 Capital One Financial Corporation Dodd-Frank Act Company-Run Stress Test Disclosures, September 16, 2013.

8 See, for example: Federal Register, *Proposed new liquidity data collection templates*, September 19, 2013.

9 Board of Governors of the Federal Reserve System, *Consolidated Supervision Framework for Large Financial Institutions*, December 2012. http://www.federalreserve.gov/bankinforeg/srletters/sr1217.htm

LIQUIDITY RISK MANAGEMENT IS A GAME CHANGER

By Cayetano Gea-Carrasco and David Little

This article discusses the importance of managing and measuring liquidity risk, regulatory guidelines and implications, and how an effective enterprise-wide stress testing program requires and integrates liquidity risk.

The 2007 global financial crisis highlighted the need to proactively manage and monitor bank solvency at an enterprise level by demonstrating the interconnectedness of liquidity risk with both financial and non-financial risks. That interconnectedness was clearly shown through the linkage of the credit quality of US subprime mortgages to the credit quality of many types of structured credit assets to the funding problems of structured investment vehicles – which led to liquidity and solvency difficulties at banks.

Although some academic papers have underscored its importance prior to the crisis, liquidity risk suffered from a lack of attention, relative to capital, by financial regulators in Basel I and Basel II frameworks. Practitioners were aware of the importance of managing and measuring liquidity risk. However, this was performed in isolation and without considering other risks; thus underestimating its impact on their institutions' solvency profiles.

Liquidity risk, to a bank's earnings and capital, arises from a bank's inability to meet obligations, expected or unexpected, when they come due. There are two primary types of liquidity risk:

- **Funding liquidity risk:** Inability to obtain the necessary funding at a reasonable cost
- **Asset liquidity risk:** Inability to liquidate assets (as necessary) at an acceptable price

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Figure 1 The proposed Federal Reserve regulation on liquidity risk is closely aligned with Basel III

Dodd-Frank Wall Street Reform and Consumer Protection Act	Fed proposal on liquidity risk management	Who will be affected in the US by the liquidity regulation?
» Sections 165 and 166: Enhanced Supervisory and Prudential requirements and Early Remediation requirements	» On June 8th, 2012 the Fed proposed final capital rules under the terms of Basel III » However, Basel III final liquidity rules (LCR, NSFR) were not included at this stage » Basel Committee finalized the LCR rules the first week of January 2013 » The Fed released the proposed rules on liquidity risk management to create a minimum LCR in October 2013	» Large BHCs and Non-bank Covered Companies » US bank holding company subsidiaries of foreign banking organizations (relying on Supervision and Regulation Letter SR 01-01)

Although liquidity risk is inherent in the banking business, given the maturity transformation between assets and liabilities, it has not been explicitly addressed in a regulatory framework until recently under Basel III (measured with the Liquidity Coverage Ratio and Net Stable Funding Ratio) or the Comprehensive Liquidity Assessment Review (CLAR), as a part of the Dodd-Frank Act Stress Tests (DFAST) in the US.[1] In addition, the Basel Committee has released a paper with a survey of industry and supervisory best practices on liquidity stress testing.[2] This paper highlights the need to improve the liquidity stress testing frameworks at institutions and major challenges from an enterprise-wide risk management perspective.

In general, there are four central topics that must be managed to effectively address enterprise-wide exposure to liquidity risk:

1. **Market liquidity risk**: Focuses on price changes and profit and loss (P&L) impacts
2. **Funding liquidity risk**: Addresses the cash flow estimation of assets and liabilities
3. **Liquidity stress testing**: Considers a financial institution's ability, in the absence of market or funding liquidity, to meet obligations during periods of stress by accurately measuring the liquidity profile of the balance sheet at an enterprise-wide level
4. **Contingency planning**: Uses the liquidity stress test findings to provide guidance about how to create a strategic plan, governance framework, and risk appetite

An effective enterprise-wide stress testing program requires liquidity stress testing

Enterprise-wide stress testing frameworks are vital for projecting the performance of a bank's strategy. By performing a sensitivity analysis of financial metrics for a given risk appetite statement and by identifying vulnerabilities under different scenarios, regulatory requirements, and business strategies, a bank can project financial results under dramatically different business environments. However, the interdependencies between capital, liquidity, and funding must also be tested for an effective and holistic view of the risks that a bank may face.

The goal of liquidity stress testing is to analyze if an institution has enough funding sources to withstand unexpected market disruptions given its balance sheet composition, funding profile, and business strategy. Although seemingly straightforward, the design and implementation of a system that effectively performs this goal in a repeatable and automated fashion is complex, with many component factors to consider.

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Meeting Basel III's liquidity risk management requirements and streamlining a liquidity stress testing process requires, ideally, an institution to have a set of qualitative and quantitative tools. They should create a robust liquidity policy and governance framework, as well as a contingency funding plan (CFP), to address their liquidity needs under stress and incorporate quantitative information generated during the liquidity stress testing process.

Institutions should develop the infrastructure and behavioral analytics to perform cash flow projections under different scenarios and generate not only the mandated regulatory required buffers, but also the liquidity stress testing metrics. They should also develop customized, forward-looking scenarios to accurately reflect their business model, and incorporate custom financial, behavioral, and economic variables according to their balance sheet composition and funding profile.

Institutions should analyze the uncertainty of asset roll-over and its ability to maintain a competitive position while generating new business under periods of liquidity stress. A limits framework that identifies potential sources of liquidity risk and concentrations of funding should be designed, implemented, and updated regularly.

Finally, to meet the regulatory and internal stakeholder requirements, institutions should build a customized set of liquidity stress testing reports. To achieve this, an enterprise-wide stress testing program should centralize the relevant liquidity management and stress testing information and methodologies. This program would ensure consistency across stressed credit and liquidity metrics, as well as a consistent analysis across the scenarios of a bank's credit, funding, liquidity, and solvency risk profiles.

Regulatory guidelines: liquidity risk management and stress testing

Basel III introduces two minimum standard ratios to proactively manage and monitor liquidity risk: the liquidity coverage ratio (LCR) and the net stable funding ratio (NSFR).[3] The LCR and NSFR calculations assign a rule-based set of weights to an institution's assets and liabilities that reflect future stressed market conditions. Based on a set of standard behavioral assumptions, these weights may make some assets more attractive than others when calculating the ratios. The two ratios are effectively liquidity stress testing metrics:

- **LCR:** Reflects a bank's ability to convert high-quality, unencumbered liquid assets to cash to offset projected cash flows during a one-month period. It is related to an institution's amount of available liquid assets to offset the projected amount of outflows over a thirty-day period.
- **NSFR:** Requires banks to maintain enough stable funding to cover the potential use of funds over a one-year period. It relates to the amount of stable funding an institution needs to offset the liquidity of the assets being funded over a one-year period.

The two ratios mean a stronger integration between credit and liquidity risk management, reflecting the interdependency between credit and liquidity metrics. Additionally, their calculation requires credit and liquidity risk information. As a consequence, institutions must analyze their cash flow, credit, and other supplementary data under stressed scenarios to facilitate the calculation and ratios parameters. At this stage, banks must also perform an optimization analysis of the high quality liquid assets (HQLA) that can be included in the liquidity ratios calculations and the cost of the carry/transferability of those assets. This is known as the HQLA optimization process.

The regulatory standard requires that institutions should continuously meet a minimum ratio of 100%. The LCR is being deployed under a 2015-2019 transition observation period to ensure that institutions have the necessary time to adjust their funding structure, increase the amount of high quality liquid assets that qualify for the ratios, and implement the necessary analytics and enterprise-wide risk architecture to support their calculation and reporting during the process. The NSFR is being revised by the Basel Committee Liquidity Working Group due to complaints from the industry about its calibration and negative effects on the maturity transformation business.

The Federal Reserve's (the Fed) proposed regulation on liquidity risk under sections 165 and 166 of the Dodd-Frank Wall Street Reform and Consumer Protection Act closely follows Basel III guidelines on liquidity risk management. However, the Fed has not yet released the final liquidity rules. The Basel Committee released the final liquidity guidelines for both ratios in January 2013 and the Fed released the final rules on capital in June 2013.

Practically speaking, the Fed's proposal on liquidity risk has two major components: a set of qualitative liquidity requirements – mainly the creation of a CFP monitoring and governance framework – and a set of quantitative liquidity requirements focused on the LCR and NSFR metrics.

Basel III liquidity implications for US institutions

As of now, the Fed intends to adopt Basel Committee liquidity ratios as the liquidity standard. In terms of coverage, large bank holding companies and non-bank covered companies, as well as some US bank holding company subsidiaries of foreign banking organizations (that rely on supervision and regulation letter SR 01-01), would be subject to these metrics.

On October 24th, the Fed released the proposed rules on liquidity risk management to create a minimum liquidity requirement (LCR).[4] The proposal is based on the standard agreed on by the Basel Committee. The core aspects are:

1. **Model-based vs. rule-based:** Haircuts and behavioral assumptions are provided, but covered companies may have to develop their own liquidity stress testing and behavioral assumptions to supplement the calculation (e.g., amount of stable deposits).
2. **Buffer composition:** There are three levels of highly liquid assets (1, 2a, and 2b), consistent with the Basel standard under the Basel III guidelines.
3. **HQLA definition:** The Fed's proposed definition of liquid assets that qualify for the buffers is different from Basel III. For example, under the Fed guidelines, only cash, securities issued, or guaranteed by the US government, a US government agency, or a US government-sponsored entity qualify as liquid assets. The exclusion of hypothecated and operational assets is also included in the proposal.
4. **LCR transition period:** Consistent with Basel III, companies must achieve a level of 100% under a transitional schedule. On January 2015, covered companies will be required to meet an LCR of 80%, which increases by 10% annually until January 2017.

The Fed has also provided guidelines on implementing effective liquidity stress testing frameworks and on expectations for supervised institutions from scenario, modeling, and governance perspectives. Liquidity stress testing must:

- Include multiple scenarios
- Be forward looking
- Be performed under different time horizons (e.g., overnight, 30-day, 90-day, and one-year time horizons)
- Use results to determine the liquidity buffer
- Incorporate the conclusions in the contingency funding plan

In addition, the Fed proposed two new liquidity risk reports templates in September 2013.[5] The new reports need cash flow information under different risk horizons, which requires a cash flow analysis that traditional ALM systems may not be able to produce without further customization. In terms of coverage, global systematically important banks (G-SIBs), foreign banking organizations, and bank holding companies will be subject to the new reporting.

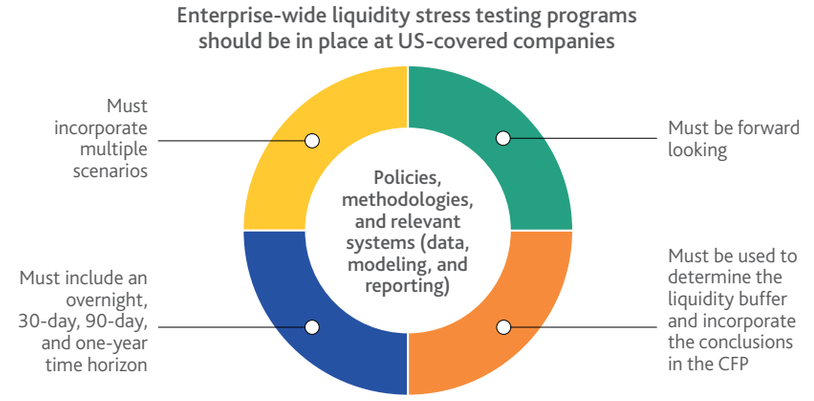
Understanding the CLAR

In addition to the forthcoming Basel III LCR and NSFR stress testing metrics in the US, the Fed has introduced a liquidity test, the CLAR. The goal is to measure liquidity risk at both an institution and system level in a similar fashion to the CCAR, but only for some large institutions at this stage.

CLAR tests a bank's ability to meet funding obligations under periods of stress. Depending on the results of this test, banks may be forced to change their funding sources or structure. Unlike the CCAR, the results of the CLAR and their methodological framework are not made public. This may render the exercise less useful for investors from a disclosure perspective. Although other countries have similar supervisory frameworks to monitor liquidity stress testing, the CLAR represents a new generation of sophistication and granularity.

The CLAR requires institutions to calculate a series of liquidity and funding stress testing metrics based on behavioral assumptions and projections that accurately reflect their true funding profile and balance sheet composition under different scenarios. This rule, in turn, affects the projected and reported liquidity stress testing and funding level from one institution to another.

Figure 2 The Fed guidelines for effective liquidity stress testing frameworks



Source: The Federal Reserve and Moody's Analytics

This requirement can only be met if the institutions apply their own internal behavioral analytics that reflect their unique characteristics of their funding and business models. Therefore, an accurate assessment of an institution's internal behaviors relies on a comprehensive characterization of both assets and liabilities under different scenarios.

There are key benefits for institutions when using behavioral models, given that they reflect unique competitive funding advantages that can enhance returns. The behavioral models offer more realistic results, which are produced by better managing assets and liabilities behavior. At this point, customer stickiness can be maximized by analyzing the funding strategy and CLAR results. Overall, this represents an opportunity to enhance returns versus using standard behavioral assumptions that often do not accurately reflect an institution's business model and liquidity profile.

An internal set of behavioral models, similar to those in the CLAR-related framework, enhances the cash flow simulation and forecasting analysis by explicitly reflecting an institution's business and funding model. For example, determining the proper parameters for behavioral assumptions in asset and liability management (ALM) systems is a crucial step toward building those systems. However, institutions typically do not pay adequate attention to the behavioral analysis to accurately reflect their balance sheet structure in the calculation. As a result, institutions may discover significant inaccuracies in their liquidity stress testing analysis, cash flows projections, funds transfer pricing metrics, funding assumptions, and liquidity metrics.

For example, analyzing borrower prepayments can have a material effect on liquidity stress testing measures and funds transfer pricing calculations. At this stage, the behavior of retail and corporate borrowers must be modeled separately. The decision of corporate borrowers to prepay their debt usually follows a function of a state-dependent rational exercise. Retail borrowers' prepayments should be analyzed using a set of explanatory factors, capturing borrower-specific information, seasonal variation, market rates, marketing campaigns, and macroeconomic factors.

> The Fed proposed two new liquidity risk reports templates in September 2013, which need cash flow information under different risk horizons – requiring a cash flow analysis that traditional ALM systems may not be able to produce without further customization.

Determining the correct maturity for exposures that have short contractual maturity, but are typically subject to review and renewal at contractual maturity, can also affect an institution's liquidity gap metric, net interest income, or earnings at risk measures for stress testing purposes. The lack of granularity on the utilization measurements for revolving credit facilities also has a material effect on liquidity buffers and funding because higher usage implies higher funding needs, and therefore higher liquidity risk.

Contingent liquidity quantifies liquidity risks

Regulators have emphasized the role of contingent liquidity in the new regulations across jurisdictions, and the need to include this metric into an institution's liquidity stress testing framework. Contingent liquidity is the cost of maintaining a sufficient cushion of high quality liquid assets to meet sudden or unexpected funding obligations and absorb potential losses.

A funds transfer pricing process is the central component of asset and liability management, as it facilitates risk transfer, profitability measurement, capital allocation, and business unit incentive alignment. The contingent liquidity comes with a real cost to an institution because it is related to the cost of the liquidity buffers. Therefore, contingent liquidity and funding costs (e.g., via funding valuation adjustments, FVA) should be allocated into an institution's FTP frameworks to manage origination activities and allocate the cost of liquidity.

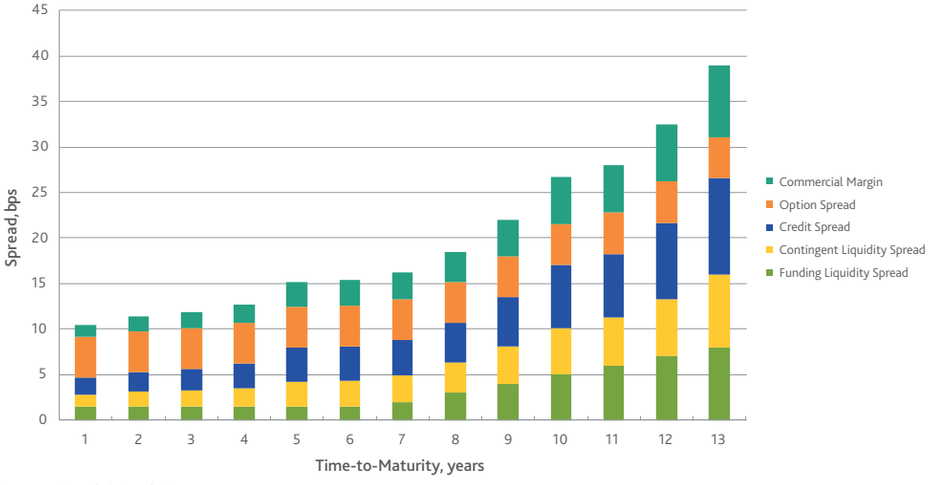
The FTP components depend on the transfers of assets and liabilities, which is driven by the business model, balance sheet composition, and desired future state. With corporate loans, for example, the FTP components should include a credit spread, which compensates the financial institution for bearing the credit risk associated with the exposure, as well as an option spread, which is a premium that compensates the bank for any embedded options in the contract (e.g., prepayment options).

The FTP framework should also include the funding liquidity spread in its calculation, which is the expected cost of funds required to support the exposure for the remainder of its life, and the contingent liquidity spread, to compensate for the cost of maintaining a sufficient cushion of high quality liquid assets to meet unexpected obligations. Figure 3 illustrates the effect of including contingent liquidity into the FTP components for a wholesale loan portfolio under different effective maturities – the longer a loan's maturity, the higher the contingent liquidity buffer.

Integrating liquidity risk within enterprise stress testing programs

Effective enterprise-wide liquidity stress testing that incorporates the methodological approaches of Basel III's LCR and NSFR stress

Figure 3 Funds transfer pricing grid: spread decomposition analysis



Source: Moody's Analytics

testing metrics with CLAR and Contingent Liquidity concepts will present a unique challenge when integrating across risk.

It is clear that an enterprise-wide architecture would be an advantage for financial institutions, but the complexity and cost of building an ideal system could be substantial. However, it will be best practice for institutions of all sizes and levels of complexity to integrate a liquidity stress testing framework into their enterprise stress testing program. There are some key aspects that must be considered when developing this framework:

- It is best practice to integrate data management infrastructure, behavioral analytics, cash flow calculation systems, and liquidity reporting systems into an enterprise risk management platform to reduce costs, improve efficiency, and automate the calculation and submission of regulatory requirements. This integration facilitates a consistent liquidity stress testing analysis across asset classes, risk types, and other stress testing-related regulatory requirements (e.g., CCAR).
- From a liquidity stress testing compliance perspective, institutions should maintain the liquidity metrics history for trend analysis, auditing, and benchmarking.
- From a workflow and data management perspective, institutions should develop centralized liquidity risk management infrastructures that strive to integrate data, stress testing analytics, and reporting.
- All information critical to calculating, managing, reporting, and monitoring the liquidity stress testing metrics should be easily calculated and cost-effective.

Finally, a liquidity stress testing framework should allow the integration of customized scenarios and internal behavioral assumptions to effectively analyze, calculate, and report liquidity and funding metrics across several dimensions, meet regulatory requirements on liquidity stress testing (e.g., CLAR), help with internal analysis (e.g., strategic funding planning and FTP), and ensure scalability by leveraging the existing systems at institutions.

1 Bank assets and liabilities are often maturity-mismatched, with long-term assets funded through short-term liabilities.

2 BIS Working paper n. 24: *Liquidity stress testing, a survey of theory, empirics and current industry and supervisory practices*.

3 Bank For International Settlements, *Basel III: International Framework for Liquidity Risk Measurement, Standard, and Monitoring*, December 2010.

4 http://www.federalreserve.gov/aboutthefed/boardmeetings/FR-notice-lcr-20131024.pdf

5 http://www.federalreserve.gov/apps/foia/proposedregs.aspx#icp

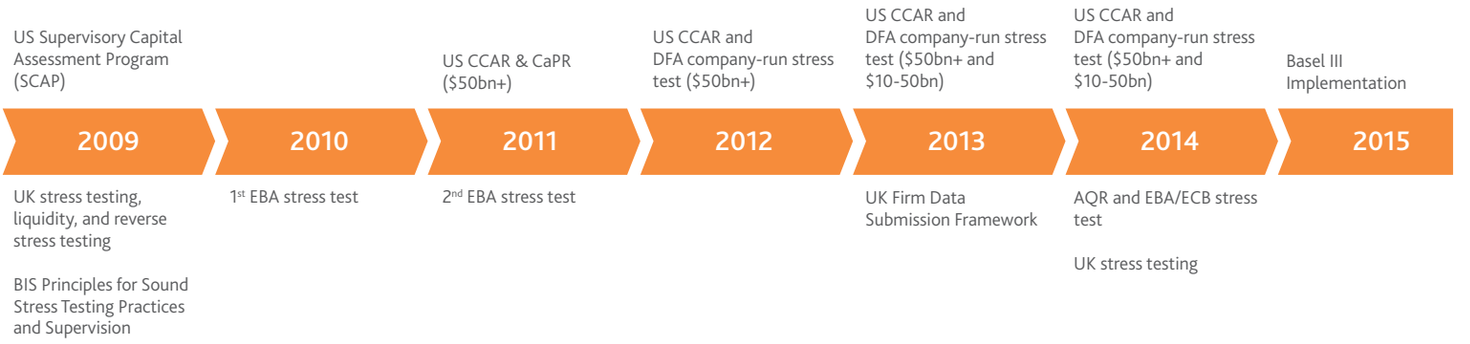
PREPARING FOR THE STRESS TESTS:
REGULATORY TIMELINE AND REQUIREMENTS

By María C. Cañamero

The Moody's Analytics Regulatory Timeline provides a high-level overview of the stress testing regulations in both the United States and European Union in the immediate and medium-term. The US CCAR stress tests will expand over the next few years, requiring both large and mid-sized banks to develop processes and systems to support the tests.

Figure 1 Regulatory timeline

Stress testing has grown in importance to become a key regulatory tool.



Source: Moody's Analytics primary market research and analysis

The US Stress Testing Requirements Guide is designed to provide a snapshot of the requirements in a simple-to-use framework. This tool is particularly helpful for stress testing exercise planning and highlights a few key trends related to stress testing regulations:

- **Tests are becoming more comprehensive:** Creating a need to forecast a wider range of risk and finance indicators
- **The scope of the tests are broadening:** Meaning that over time more banks are required to conduct annual internal and supervisory stress tests
- **The frequency of the tests is increasing:** Requiring quarterly calculations and semi-annual to annual reporting of stress testing results
- **More transparency is required:** Increasing disclosures by banks and SIFIs is required to meet market confidence objectives

Figure 2 US Stress Testing Requirements Guide

		>$50bn			$10-$50bn
		CCAR	DFAST		
			Supervisory Stress Test	Company-run Stress Test	Company-run Stress Test
Frequency		Annual	Annual	Semi-annual	Annual (from November 1, 2013)
Target		29 BHCs (18 BHCs + 11 firms previously under CapPR subject to CCAR from Fall 2013)			Approx. 70 firms
Milestones	» Regulatory scenarios provided by	Mid-November			
	» Test results reported to regulator by	January 5th		January 5th / July 5th (Mid-cycle stress test)	March 31st
	» Public disclosure of results by	March 15th – 31st	March 31st	March 15th – 31st / September 15th – 30th (Mid-cycle stress test)	June 15th – 31st
Methodology	Scenarios	» 3 regulatory scenarios: baseline, adverse, severely adverse	» 3 regulatory scenarios: baseline, adverse, severely adverse » Market risk scenario[1]	» 3 regulatory scenarios: baseline, adverse, severely adverse » 2 firm-built scenarios: baseline, stress	» 3 regulatory scenarios: baseline, adverse, severely adverse
	Planning horizon	9 Quarters[2]			
	Calculations required by quarter end	Losses, PPNR, provisions for loans and leases, net revenues, balance sheet, RWA, and capital			
	Loan loss estimation	At loan and security level for all material portfolios			Flexibility allowed: aggregate (portfolio level), loan-segment level or loan by loan level
	Regulators' models applied to banks' data	Yes (Supervisory stress test results are inputs to CCAR)		No	
	Capital actions assumption	BHCs' planned capital actions[3]	Standardized set of capital action assumptions[4]		

Source: Moody's Analytics

1 Applicable to 6 BHCs with large trading, private equity, and counterparty exposures from derivatives and financing transactions.

2 Planning horizon: December 31st year x through December 31st year x+2. Data as of September 30th year x for annual stress tests. Data as of March 31st year x for semi-annual stress tests.

3 The Fed uses BHCs' planned capital actions, and assesses whether a BHC would be capable of meeting supervisory expectations for minimum capital ratios even if stressful conditions emerged and the BHC did not reduce planned capital distributions.

4 Each BHC maintains its common stock dividend payments at the same level as the previous year; scheduled dividend, interest, or principal payments on any other capital instrument eligible for inclusion in the numerator of a regulatory capital ratio are assumed to be paid; but repurchases of such capital instruments and issuance of stock is assumed to be zero.

STRESS TESTING – A RETURN TO RAP VS. GAAP?

By Michael Fadil

Michael Fadil
Senior Director, Capital Stress Testing Business Development

With more than 25 years of experience, Michael provides deep insight into loan loss reserves, commercial model development, economic capital modeling, and model validation. He also is a primary architect of the Capital Stress Testing program, beginning with SCAP.

Although banks have made significant strides in many areas of stress testing, opportunities for improvement remain. This article discusses how several key stress testing modeling aspects still need to be addressed.

The Dodd-Frank Stress Test (DFAST) and Comprehensive Capital Analysis and Review (CCAR) results were released by the Federal Reserve (the Fed) in mid-March.[1] When combined with the methodology documents published by the Fed, a somewhat detailed overview emerges for assessing banks' abilities to withstand stressed economic downturns. Banks and other systemically important financial institutions (SIFIs) that submitted or expect to submit stress test results are thoroughly reviewing this documentation to improve their institutional stress testing methodology.

In order for banks to forecast their balance sheets and income statements, however, they may need to use a methodology different from what is described in that documentation. This article reviews the methodology outlined by the Fed in detail and outlines some areas in which banks and SIFIs may seek to modify their approach.

The stress testing dilemma: choosing a modeling methodology

The Fed desires that each bank's stress testing program become more than just a regulatory compliance exercise – it envisions banks using their programs to better inform strategic and business planning, risk appetite, and advanced risk management practices. Many of the primary methodologies described in the Fed's published documents, however, create a challenge for banks to achieve this vision and appear to be inconsistent with Generally Accepted Accounting Principles (GAAP).

Conversations with chief risk officers and other top executives at larger banks would seem to confirm this dilemma. Banks struggle as to whether they model the stress tests on an accrual accounting basis, which would allow them to best leverage the exercise for their business practices, or model the stress scenarios using the methodology as described by the Fed. Additionally, some are also considering whether they should forecast under both methodologies – reminiscent of when banks had to prepare and report financial results under ***both*** GAAP and Regulatory Accounting Principles (RAP) accounting.

The pitfalls of an EL-based loss approach

The loss forecasting methodology explained by the Fed in their documentation is an expected loss, or EL-based methodology. This methodology is preferred by risk modelers and can most accurately be described as a mark-to-market (MTM) view of accounting, despite the fact that a vast majority of most banks' loans are governed by accrual accounting. The EL-based loss approach assumes that all losses are realized at the time of default. In reality, banks account for loan "losses" as charge-offs, not EL. Accounting charge-offs usually occur over time, not in full at the time of default. The time lag associated with loan charge-offs can be

very important in Commercial Real Estate (CRE) portfolios, and more recently with mortgage portfolios in judicial states where the foreclosure process can extend to years. In these portfolios, often only 60-70% of the losses are realized as charge-offs in the first four quarters. The two methodologies will equal out over the long term, but nine quarters is typically not enough time for this conversion to happen.

Incorporating a loss emergence vector

The basic EL building blocks – Probability of Default (PD), Loss Given Default (LGD), and Exposure at Default (EAD) – provide 90% or more of what is required to forecast charge-offs instead of EL losses.

In addition, banks need to incorporate a loss emergence vector, which describes how much of the LGD is realized as a charge-off by quarter after default (in Q1, Q2, Q3, etc.). The loss emergence vector will vary by loan product type and collateral type. It may also vary based on location of the collateral, especially in the instance of CRE or residential mortgage loans, where the ability of a bank to act on its collateral in judicial states can be much slower. Without the key information provided by the loss emergence vector, banks are reduced to oversimplifying the modeling process and may be overstating losses in a nine-quarter forecasting exercise.

Without the key information provided by the loss emergence vector, banks are reduced to oversimplifying the modeling process and overstating losses in a nine-quarter forecasting exercise.

Forecasting non-performing loans

The MTM accounting treatment that the Fed employs also negatively affects the ability to accurately forecast non-performing loans (NPLs), a key credit quality metric employed by both banks and regulators. NPL balances are changed primarily one factor that increases, and three that reduce, NPL balances. New inflows into NPLs increase the balances. This metric is modeled using a conditional PD or conditional credit transition matrix approach. Reductions to NPL balances are:

1. Reclassifications of non-performing loans back to performing
2. Charge-offs
3. Payments made on the loan

Payments can include any payments by the borrower or guarantor or any type of sale of the collateral securing the loan.

Modeling payment-related NPL reductions

It is commonly known that the methodology the Fed employs for losses generally accelerates the reductions to NPLs. By using ELs instead of charge-offs, the NPL balances are reduced more aggressively than what actually occurs in practice at banks. But what about the payment-related reductions?

To model the payment-related NPL reductions, banks need to additionally employ a principal balance reduction vector, similar to the loss emergence vector. Just as the loss emergence vector is applied to the LGD to accurately model when the losses are realized as charge-offs, the principal balance reduction vector is applied to one minus the LGD (which equals the amount of the defaulted loan a bank will ultimately get repaid) to identify when the payments on the non-performing loan will be received. The Fed methodology document is silent on this key aspect of NPL modeling. Given that the methodology document covers other pieces of the documentation in adequate detail, we can assume that nothing will be done for this aspect of NPL balance forecast modeling. How then can banks apply the Fed methodology in a manner that will be helpful for them if the modeling process does not reflect the established market practice of, nor provide sufficient guidance on, NPL balance forecasting?

Regarding ALLL

The Fed describes a process whereby the allowance for loan and lease losses (ALLL) is simply the sum of the next four quarters of stressed losses. First, we must remember that the Fed's losses are not charge-offs, and will be higher – sometimes materially higher – than charge-offs in a stressed nine-quarter forecast. Even more important, however, is the fact that the Fed model does not align with how the ALLL is estimated by banks. Accounting firms would frown upon an ALLL method that is based on a forecasted four quarters of severely adverse stressed forward losses.

The ALLL is designed to account for incurred but unrealized losses. It is not intended to be a reserve against stressed potential losses, which is how the Fed is modeling the ALLL forecast. A proper framework would align to a bank's three primary ALLL components: FAS 5 pool reserves, FAS 114 reserves, and an unallocated reserve. These could be modeled using a function of the ELs for each portfolio at each future reporting period for the FAS 5 pool reserve, a function of the forecasted NPL balances at each future reporting period for the FAS 114 reserve, and a separate overlay for the forecasted unallocated reserves. Similar to the loss forecasting component of the stress test, it is impossible for a bank to forecast the ALLL for stress test purposes that will be applicable for both DFAST / CCAR and the bank's internal management, unless a bank reverts to both a GAAP and RAP stress testing forecasting.

Even more important, however, is the fact that the Fed model does not align to how the ALLL is estimated by banks. Accounting firms would frown upon an ALLL method that is based on a forecasted four quarters of severely adverse stressed forward losses.

Top-down forecasting of net charge-offs

Finally, the 2013 DFAST methodology document describes an alternative loss methodology employed by the Fed to forecast net charge-offs (NCOs). In a one sentence paragraph on page 44, the second approach is described as "models capture the historical behavior of net charge-offs relative to changes in macroeconomic and financial market variables and loan portfolio characteristics."[2] Alternative methodologies are always good to have, but it appears the methodology the Fed uses could be improved.

Although it is impossible to say with certainty, the description indicates that the Fed directly models NCOs. Such a process does not work well, especially in the instances of commercial and CRE portfolios due to the long lag between gross charge-offs (GCOs) and recoveries. NCOs represent GCOs, minus recoveries. GCOs are a reflection of current credit conditions; however, recoveries are a function of prior GCOs, and therefore some prior period economic and credit conditions. When banks perform econometric modeling on NCOs, the true result of what is happening in the economy and credit cycle is reflected in the GCO time series, but noise is added by the inclusion of recoveries in the NCO time series. Therefore, banks should not include recoveries in this type of econometric modeling, but rather model the specific loan portfolio GCO time series econometrically and then separately forecast the specific loan portfolio recoveries as a lagged function of prior GCOs.

This article intends to offer a new perspective on the concept of stress testing for capital adequacy purposes. By reviewing the methodology in detail, we seek to highlight some of the accounting challenges banks and SIFIs may face in applying the principles put forth by the Fed.

Banks, regulators, and other market participants should be commended for the progress made so far on this important market initiative. Many aspects of stress testing are significant improvements over the previous methodologies banks employed to assess capital adequacy. Specifically, using a nine-quarter horizon, in

conjunction with the requirement to stay well capitalized throughout the entire horizon, greatly improves the solvency of the system. This policy, including the substantial improvement in disclosure and transparency, leads market participants to a much higher degree of confidence in financial counterparty transactions and consequently financial system liquidity. Furthermore, banks have made significant strides in improving their risk governance, cultures, systems, and models. Nonetheless, opportunities for improvement remain. This article covers several key stress testing modeling aspects that need to be addressed. We remain optimistic, however, that regulatory clarity for some of these crucial issues will be forthcoming.

1 Board of Governors of The Federal Reserve System, *Dodd-Frank Act Stress Test 2013: Supervisory Stress Test Methodology and Results*, March 2013.

2 Board of Governors of The Federal Reserve System, *Comprehensive Capital Analysis and Review 2013: Assessment Framework and Results*, March 2013.

THE CHALLENGES OF STRESS TESTING US STRUCTURED FINANCE

By Andrew Jacobs and Stephen Clarke

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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 US structured finance portfolios presents a unique challenge – nowhere is tail-risk analysis more critical yet more difficult to complete. 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 organizationally and analytically. However, when a bank conducts stress testing, it must consistently apply stresses to all its positions regardless of asset class.

An inherently involved and complex process

Looking at a structured finance portfolio as a whole can yield useful generalizations 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 difficult to know intuitively how a change in a given macroeconomic statistic will affect a single position. Depending on deal structure, it is possible that severe economic scenarios could improve the relative performance of some tranches and cause significant losses to others. Banks cannot determine the impact on structured finance tranches without running the cash flows on the underlying properties and loans and then passing those cash flows through the deal's waterfall. And yet, running the cash flows opens up a 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 the bank's positions. In the world of structured finance, this ideally means crafting projections at the underlying loan-level. The United States is one country, but each of its fifty states has unique laws and economic environments, which means granular data at the loan-level is critical. For RMBS, the state where each loan was issued has either judicial or non-judicial mortgage laws, determining how long foreclosure proceedings could last. Loan-level data can be frustratingly scarce, especially for certain structured finance asset classes like ABS, which contributes to a dearth of granular structured finance asset models.

Lower coverage for loan-level data makes it hard, if not sometimes impossible, to develop reliable account-level models in the first place. It also means that any successful stress testing model must simultaneously and consistently support alternate methodologies. As an example, consider a bank with whole loan mortgages and RMBS on its books. The whole loans may be stressed through an account-level asset model, whereas, due to weak reporting, some of the RMBS positions 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 are not limited to the underlying assets. Many transactions include one or many swaps intended to protect against credit risk, basis risk, and so on. However, swaps themselves introduce 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 fore 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 often need to scour performance reports and deal 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 and scalable 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 standard 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 and model design, and ongoing support. Consistency across all portfolio assets is imperative to stress testing best practices.

> Loan-level data can be frustratingly scarce, especially for certain structured finance asset classes like ABS, which contributes to a dearth of granular structured finance asset models.

CCAR AND DFAST: WHAT WILL 2014 BRING?

An Interview with Thomas Day

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

Learn how the Comprehensive Capital Analysis and Review and Dodd-Frank Act Stress Tests will impact banks in 2014 and how banks can best prepare for the changes.

What changes should risk managers expect with CCAR in 2014?

When reviewing CCAR banks with over $50 billion in assets, regulators will increasingly focus on infrastructure and automation in 2014. The report issued by the Fed in August 2013, titled *Capital Planning at Large Bank Holding Companies: Supervisory Expectations and Range of Current Practice*, emphasizes process control, automation, and integration, as well as various elements of the stress test forecast itself.[1]

In my view, there are three topics that these banks will find particularly interesting in the report. The first topic, covered extensively in the report, is the lack of integration of loss estimation within the Pre-Provision Net Revenue (PPNR) calculation. Since this integration has proven a weakness for many banks, it will attract more attention.

A second area of increased focus is on challenger models. These models are not the primary models used for the derivation of the CCAR results; instead, they are used to challenge the production models, ensuring they provide consistent and accurate results.

Finally, there is an increased emphasis on validating those production models. As the CCAR banks prepare for the tests, these are a few of the areas on which they may choose to focus.

How will modeling requirements change, especially regarding loss modeling and PPNR modeling?

The DFAST banks under $50 billion in assets are asked to file their first submission on March 31, 2014. As a result, participants have many questions about the type of estimation practices for credit risk and loss estimation they should use. Many elements of the stress test that should be given the highest attention pertain to loss estimation. Typically, smaller banks implement basic top-down types of models, which are appropriate for pools of assets that are fairly homogeneous. That said, these banks would benefit from learning more about heterogeneous asset classes and those that have what I like to call "chunkier" types of exposures, like C&I and CRE.

I anticipate that regulators are expecting more advanced methodologies for loss estimation than simple top-down models that try to make an existing probability of default (PD) sensitive to macroeconomic factors in a simple regression-based model.

Regulators are also keen to see how models at smaller banks are supported by the data and the risk rating process within those organizations. Many smaller banks still struggle with creating dual risk rating systems and the data layer to support the loss estimation. Therefore, I anticipate these banks will seek improved methodologies around their models in mid-2014.

With regards to PPNR, it's crucial that banks integrate the estimated losses and the scenarios producing those estimated losses on the credit risk side. As losses begin to emerge, the loans migrate to a non-performing or non-accrual

status, creating a drag on a bank's net interest margin. This loss emergence process needs to be better integrated.

A missing link has been the incorporation of liquidity into CCAR and DFAST. Do you think this will change in 2014?

That's a great question. When systems, platforms, and models are built correctly, liquidity risk can be more naturally accommodated. That's not, however, the regulatory expectation or direction. In my opinion, liquidity risk will not be brought into the CCAR or DFAST framework. That said, sometime soon I do expect the regulators will publish new rules that provide additional guidance about modeling expectations for liquidity risk. Liquidity risk will remain a separate exercise, and it has the potential to be equally as challenging as the CCAR process.

What in particular makes liquidity risk as challenging as CCAR?

Banks typically deal with cash flows and time horizons. For example, with asset liquidity, they have to consider different economic scenarios, and how quickly they can get rid of unencumbered liquid assets. A second consideration is treatment across the asset classes, as the time horizons for liquidation change with economic scenarios. When moving into a crisis, the liquidity that banks thought they had on day one could be gone on day fifteen, as the scenario continues to matriculate through their balance sheet and the market.

Modeling challenges also exist with collateral valuation. The time windows are not orderly over nine quarters. In fact, the time windows are over 1-5, 6-15, 15-30, 60, or 90 days. Banks have to produce the liquidity cash flows over these short-term time horizons, while simultaneously having to revalue their assets and any posted collateral, or collateral that is unencumbered that may be "called," for additional collateralization of secured financing arrangements.

Not only that, but there are other challenges, such as including a contingency funding plan in the scenario and determining how those contingent sources of funds might be changing, and how off-balance vehicles may not be a direct obligation and instead might be a moral recourse or indirect obligation. There are a range of additional issues that banks may not necessarily consider in the context of the CCAR process. It is going to be a learning exercise as the regulators promulgate the new policy and the industry becomes familiar with a higher set of supervisory expectations around liquidity management. It might be a good idea to acquaint yourself with SR 12-17, which deals with the new continuous monitoring and supervisory framework for larger banks. It discusses the need for better resiliency and resolvability and how the Fed plans to implement that policy.

What can banks do to become streamlined and make the CCAR/DFAST process less resource and time-consuming?

In most banks we have worked with, the process is not streamlined and is very time-consuming. For now, improvements are slow. In order to overcome these issues, banks need to develop an automation plan and strategy while recognizing that the issues are not going to be quickly fixed. The reason the CCAR exercise is so time-consuming is that it involves every element of an organization. It is an enterprise-wide stress test that crosses all of the data across the full, consolidated balance sheet, requiring banks to capture all that data and forecast balance sheets, income statements, and regulatory capital under different periods of stress, over two-plus years.

Banks have not been investing in automation, business process management, and workflow tools, let alone a datamart that contains the data necessary to estimate the models and produce analytics. A significant investment is required to create that automation. Unfortunately, there is no simple solution to this complex problem, which is not going away. Banks will have to make investments to get it right.

One lesson learned in our interactions with banks is the benefit of a dedicated stress testing architect. That role would endeavor to understand the current state environment. The stress test architect would be a decision maker who can break down organizational bottlenecks and bring a bank from a current state to a better state. Why better state instead of future state? In my opinion, to date, no one has a clear

vision of what a future state design looks like. It varies from bank to bank, given how different systems have evolved and how organizations are structured, such as their automation type and architecture.

Finally, I recommend that banks establish a Stress Testing and Capital Planning Office, which is a group that functions as the "go-to" center of competence for keeping up with policies, expectations around internal controls, governance, research, writing procedures, and validation plans. The validation or governance function would ensure both primary models and feeder models into the primary models are being validated and assessed in the proper fashion. The office may include elements of technical writing, particularly around policy and procedure.

The Stress Testing Office would most likely contain the stress testing architect, but the office itself would fulfill a variety of different duties. Other facets of the office include data management and workflow control. One example is making sure internal audit groups responsible for checking elements of the stress testing process are performing their duties and putting a harness around the entirety of the exercise to make sure it is working properly. The office may report to the board, keeping the board abreast of the stress testing program quality, and also serve as the regulatory liaison to ensure the regulators are given all the necessary information about the stress testing and capital planning process.

The Stress Testing Office may fit within the finance group, risk management group, or form a part of regulatory reporting with the understanding that headcount is needed to manage the entirety of the process in a structured and efficient manner.

What have been the areas of greatest focus for banks as they move toward the 2014 cycle?

Increasing the quality of loss estimation models across all asset classes is an area of primary focus for 2014 and will most likely continue indefinitely. Banks need to think more about back-testing and benchmarking models. On the PPNR side, the integration of loss estimation within the margin element of the PPNR calculation will be important.

When estimating a balance sheet over a nine-quarter period, banks will have different estimates of new business production or origination strategy as they move through a base case, more adverse, or an idiosyncratic scenario. Many finance groups that typically generate a base case new business origination strategy are not necessarily accustomed to estimating what the credit-adjusted new business volumes would be, and their associated Basel risk-weighted asset category. They are not comfortable estimating the associated credit distribution of that new business volume – especially under adverse economic conditions – and need input from credit risk and the risk originating business line. When banks have to produce a pro forma forecast that estimates risk-weighted assets at every quarter end, they will have to estimate the business volume under the different scenarios, with the added dimension of the credit quality of that new business origination. This includes understanding not only volume, but also the maturity of that new business origination, the product category, and the pricing spread (e.g., fixed, floating, compared to the index rate, etc.). The supervisors will not expect a simple qualitative overlay or average risk ratings by account type as has been acceptable so far, and will instead look for quantitative estimation of these levels with more specificity.

On the non-interest revenue / non-interest expense side, in most cases the estimation of those levels typically comes from the finance group, or fairly simple regressions based on past data. Regulators are concerned about how this estimation is impacted by stressful conditions. The legal costs associated with mortgage put backs, for example, might increase substantially in another housing crisis, as well as foreclosure costs, and other litigation and operational expenses. Another example would be if there was a catastrophe in the money fund industry, and people rushed to the bank. This might sound like a great outcome for banks, but there is such a thing as being too liquid. The regulatory expectation is that the forecast will be more

sensitive to the economic scenarios and more thought will be put into the quantification of those elements.

On the data management side, there has been a significant under-investment in automating the data layers. Banks need to better automate that process, link to different core systems, and bring that data into a common framework for purposes of submitting the required regulatory reports.

The issue of capital forecasting and forecasting RWA is going to be potentially an area of increased focus for CCAR banks. I do not think it is going to be an issue for DFAST banks, given the fact a lot of Basel I reporting rules are still in play. For larger banks, creating a better process for forecasting RWA is going to be an important piece. And new business volumes and spreads need to be linked up in a tighter fashion.

What would be the highest priorities for banks with over $50 billion in assets and under $50 billion in assets for the 2014 stress testing cycle?

The banks with over $50 billion in assets have been hit hard for a number of years on the analytics side. The focus on infrastructure, governance, and process should be a high priority. Several of the banks that published in March 2013 were hit with concerns regarding process and governance. In my opinion, that trend will continue. *The Capital Planning at Large Bank Holding Companies: Supervisory Expectations and Range of Current Practice* report makes the same point. Judging by the number of weaknesses identified in the report, it is clear that the supervisory authorities have plenty of ammo. Larger banks should still keep a laser-like eye on analytics, but clearly think about infrastructure, as well as tricky areas like new business volumes and creating more sensitivity around the non-interest revenue / non-interest expense pieces.

For the banks with under $50 billion in assets, the problem is a little bit easier. The regulators expect the processes around the loss estimation for credit risk to be far more advanced than other elements of the stress test, especially for banks in that $10 to 50 billion in assets category.

Organizations often focus on minimizing cost rather than on understanding how best to model a particular asset class. For example with C&I loans, banks have to model stressed PDs at a minimum by sector and certainly from a bottom-up perspective, rather than from a top-down perspective. Banks often need to invest in better rating systems. If that means acquiring a new spreading tool that allows them to apply a default PD or LGD model to estimate those two quantities, then they need to invest. They may also need to simultaneously invest in new analytics and techniques to transform measures into stressed measures.

In my opinion, regulators will not be satisfied with top-down modeling approaches for asset classes that have idiosyncratic features, even for banks with $10-50 billion in assets. Supervisory authorities have been expecting enhanced rating systems for years. DFAST banks that still have not invested in them may learn a harsh lesson in 2014 about what is and is not satisfactory. That is why the banks with under $50 billion in assets should primarily focus on credit risk analytics and rating systems, as well as allowance methodologies.

1 http://www.federalreserve.gov/bankinforeg/bcreg20130819a1.pdf

APPROACHES TO IMPLEMENTATION

Examines how to implement a stress testing program, including model risk management, modeling the entire balance sheet, and the intersection of CCAR and Basel.

THE NEED FOR MODEL RISK MANAGEMENT

By Michael van Steen

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This article presents the various components of the model risk management framework institutions employ to meet their need to build, manage, and benefit from the models they use.

Models have long been part of the toolkit used by the financial community to assess, price, and manage the various risks they face. As computing power increases, available data sets expand, and statistical techniques grow in sophistication, these statistical, financial, mathematical, and economic tools have become increasingly central to the operation of individual financial institutions and also to the financial system as a whole. Models and, in many cases, model systems built by taking the outputs of various models and using them as inputs to other models, provide many benefits to firms. Yet, they are also an emerging risk factor as model failure or misuse can seriously damage the finances, reputations, and even the solvency of firms.

Prudent management and, increasingly, regulations have institutions looking closely at the models they employ. This article presents the various components of the model risk management framework institutions use to meet their need to build, manage, and benefit from the models they use.

The need for model risk management

Models are now critical, if not central, to the success of financial businesses. There are numerous adverse consequences that could result from fundamental model errors, use of erroneous inputs or assumptions, unauthorized model use or changes, or use of a model outside of its developed purpose. Unfavorable model consequences include:

- Ill-formed underwriting
- Underpriced risk
- Incorrect assumptions about market liquidity in times of crisis
- Misguided asset diversification strategies
- Operational gridlock if models are not available or are viewed as unreliable
- Compliance issues from model decisions, particularly around retail lending
- Loss of institutional and market knowledge if models are viewed as just "black boxes"

In addition to individual model failure, many models use as input the output of other models (e.g., a portfolio model uses modeled probability of default values as input) – small errors in one model might be compounded or amplified when their erroneous results are fed into other models.

The post-crisis regulatory environment is looking to mitigate these various model risks by refocusing institutional attention on the models they use. In particular, the Basel Committee publications and, in the United States, the OCC's Supervisory Guidance on model risk management (OCC 2011-12), require institutions to have a model risk management framework.

AREAS OF MODEL RISK MANAGEMENT

Model risk management is the establishment of a framework at an institution that not only provides insight into the use, nature, type, and development of models used at that firm, but is also a mechanism that controls a model's deployment and range of applications, and (if needed) stops the use of those models.

This model risk management, per the OCC, "should include disciplined and knowledgeable development and implementation processes that are consistent with the situation and goals of the model user and with bank policy."[1] Attaining regulatory compliance is a key goal of model risk management at institutions; therefore, this OCC guidance serves as a key starting point in the creation of a model management framework. In particular, the following areas are critical in model management frameworks:

- Model development
- Testing and validation
- Implementation
- Oversight and audit
- Governance

These areas are examined in the following sections.

Model development

The model development process must always begin with the establishment of clear goals. These goals – such as, efficiency improvements, reducing expected losses, or deploying better pricing – provide the teams developing the models with insight into their ultimate use. The goals should also supply guidance about the tests and criteria on which their models will be judged.

Once goals are established, the model development teams should undertake a methodical survey of the data, resources, and models available both inside the firm and from external sources. Models have been around sufficiently long enough that no firm, however large, has a "monopoly" on the modeling insights or data observations of a particular region or asset class. There are numerous data vendors, dedicated statistical shops, and model suppliers that can potentially meet the modeling needs of a firm. These options should be examined in conjunction with internally available resources, as it is often the case that external tools or data are used with internal resources. For example, third-party data sets covering time periods and regions not available internally are combined with internal data sets to produce a richer modeling data set. Additionally, external models and statistical groups are often used to benchmark or function as challengers to internally-developed models.

The actual model development process must constantly produce documentary evidence to support model choices. Additionally, model development should:

- Strive to avoid oversimplification
- Have rigorous variable selection and variable exclusion criteria
- Evaluate the appropriateness of qualitative overlays and modifications to date
- Employ the best available statistical and analytic rigor to their modeling effort

The result of these efforts, beyond a model the institution can use, should be a clearly documented and theoretically justified package of code and source data sets (with all data modifications and overlays clearly defined and explained) ready for evaluation and testing by groups not connected with the modeling effort.

> The post-crisis regulatory environment is looking to mitigate these various model risks. In particular, the Basel Committee publications and, in the United States, the OCC's Supervisory Guidance on Model Risk Management (OCC 2011-12), require institutions to have a Model Risk Management framework.

Testing and validation

Testing and validation are critical parts for both the development and ultimate acceptance of a model by the business lines using the model and external regulators reviewing the models, when deployed. It should be viewed as a complementary and integral part of the model development process, as the clearly defined code and thorough data preparation needed for testing and validation greatly aids the initial development and subsequent improvements to the model.

Model testing and validation teams need to be somewhat independent from model development and use, typically through differing reporting lines. The personnel conducting the validation should be able to, based on their skills and organizational standing, challenge model developers on a regular basis. In particular, they should examine and effectively comment on all aspects of a model, including inputs, analytics, reporting, and performance. If needed, they should be able to prevent a model that doesn't pass their criteria from being utilized by the institution.

Testing and validation focuses on three areas:

1. Testing and validation of the conceptual soundness of the model
2. Identifying potential limitations in the model and in its range of applicability
3. Evaluating model effectiveness, both through back testing and periodic reviews of model results

Model testing and validating utilizes a variety of methods. Unit testing of model variables checks for accuracy, demonstrates model stability and robustness, evaluates the proper fit of variables, and, particularly through sensitivity analysis, assesses model limitations by entering a range of extreme model values. Out-of-sample testing, if possible, includes the use of external data, further tests model stability and performance, and provides a particularly strong challenge to the model under consideration. Finally, regular analytic and statistical model reviews aim to ensure that models perform as expected and within their design parameters, highlight potential model limitations and prescribe corrective actions, and reaffirm the model's limitations and range of applicability.

The testing and validation areas should regularly employ either specified or statistically determined "stressed" model input variables to evaluate the soundness and performance of models under consideration.

Implementation

Typically, after iterative and rigorous model development, testing, and validation work, the implementation of models is an often overlooked activity at institutions. Effective implementation should not be discounted, as there are numerous ways in which an erroneous deployment will negate the hard work and resources expended to create and validate the model. For example, many deployed models blindly pick up dated financial information, utilize hard-coded estimates of market volatility (i.e., the market estimates that largely define the model's behavior in times of high stress), and execute queries against input data stores so inefficiently that end users successfully demanded the ability to bypass the use of the model.

To ensure a successful implementation, the model development team should understand the ultimate platform that will host the model, while technology resources should have early opportunities to comment on the model's overall goals. This enables the team to identify potentially burdensome technical requirements early on and design mitigations. For example, one model's initial requirement of instant real-time data feeds from tightly-controlled source systems was, on investigation of the nature and criticality of this data, changed to a data snapshot generated daily by the system. The overall stability, security, and speed of the model greatly increased, while the model's technical complexity decreased. Furthermore, the model's overall predictive power was not affected.

Effective model implementation should not be discounted, as there are numerous ways in which an erroneous deployment will negate the hard work and resources expended to create and validate the model.

Increasing the overall visibility of model inputs and outputs should also be a goal of the implementation. Models typically receive automated feeds from many sources, including, for example, interest rate curves, cost of funds estimates, and balance sheet data. Additionally, models likely utilize various infrequently updated or even hardcoded values, such as the firm's unit costs, leverage targets, and target debt service

coverage ratios. This data is often a critical driver of model results, so its misuse or misapplication can produce erroneous model results. During times of stress, for example, one does not want data that assumes market liquidity and an ample supply of buyers and sellers across all risk categories. This would likely greatly underestimate the risks of being in a certain market and potentially precludes management from identifying and stopping the addition of more risky exposures on their balance sheet. In summary, model users and the groups overseeing the model should be aware of this data, be able to quickly find the current values being used, and change this data in a timely fashion.

The oversight and audit area, as the testing and validation area, requires knowledgeable teams that are able to identify, quantify, and propose changes to models. Specifically, organizations need these areas to have the incentive, competence, and influence to effectively understand, audit, and challenge the models.

Governance

Model governance determines which models are used, the range of activities they cover, the type and nature of tests they need to be subjected to, and, ultimately, when to stop using a particular model. Governance provides the first and last methods of controlling models, as an institution's management structure ultimately is responsible for the ways models are used. Key governance activities should include:

- Maintaining a comprehensive inventory of information used in models, data used for model development, test results, the models being used, models recently retired, and proposed models
- Mandating, and strictly using, a revision control system for model code
- Aiming to build up sufficient model knowledge outside of groups that do model development, while recognizing that modelers and decision makers typically come from differing backgrounds and potentially view models differently
- Establishing limits on model use and alert mechanisms when models exceed the limits
- Utilizing strictly-defined roles and responsibilities
- Building the capabilities to regularly monitor model performance through unit testing, operational efficiency checks, performance against model development metrics and similar benchmarks, and out-of-sample testing

To ensure a successful implementation, the model development team should understand the ultimate platform that will host the model, while technology resources should have early opportunities to comment on the model's overall goals.

Oversight and audit

Models must capture the complexity of the institution and the phenomena they want to simulate. In practice, while the creation and testing of models is somewhat straightforward, ensuring that a particular model "works" (for lack of a better term) is particularly challenging.

Model oversight and audit aims to build confidence in models by subjecting them and their results to a variety of conceptual and quantitative criteria. While testing and validation focuses on building up a rigorous body of evidence to support a particular model, oversight and audit aims to provide an effective challenge to these models by:

- Challenging the modeling teams to establish the conceptual soundness of their models and why their chosen approach should be used over competing approaches
- Establishing or expanding identified limits to a model and then identifying, quantifying, and proposing changes to that model
- Reviewing the history of decisions made by a particular model and then comparing these decisions and their outcomes with both the model development data set and the results predicted at the time of model creation

These steps greatly increase a firm's ability to know, monitor, and govern the models used at their firms. Models offer many advantages, yet they must be thoroughly understood. They must be rigorously developed, tested, and monitored, and they must be governed and controlled by the key risk and management areas of an institution. A model risk management framework enables a firm to accomplish all these goals, thereby managing their models instead of being (mis) managed by them.

1 Federal Reserve / OCC, *Supervisory Guidance on Model Risk Management*, (SR 11-7/OCC 2011-12), April 2011. http://www.occ.treas.gov/news-issuances/bulletins/2011/bulletin-2011-12a.pdf

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MODELING THE ENTIRE BALANCE SHEET OF A BANK

By Dr. Tony Hughes

Dr. Tony Hughes
Managing Director of Credit Analytics

Tony manages Moody's Analytics credit analysis consulting projects for global lending institutions. An expert applied econometrician, he has helped develop approaches to stress testing and loss forecasting in retail, C&I, and CRE portfolios.

This article explores the interaction between a bank's various models and how they may be built into a comprehensive stress testing framework, contributing to the overall performance of a bank.

The role of stress testing is to reduce the likelihood of a bailout in future crises. The notion that the government will bail out a bank if credit losses spike is no longer considered a valid capital adequacy plan. Stress tests and the resulting restrictions on bank dividend payouts are designed to ensure that, when the next crisis occurs, all banks will be able to weather the storm with sufficient capital already on the books.

From a modeling standpoint, the fact that excess credit losses can cause a depositor retreat belies the notion that a bank is merely the sum of its individual parts. Despite this, the models developed during the short history of stress testing have been highly compartmentalized. Banks typically have models for mortgages, credit cards, commercial and industrial portfolios, and deposits, but nothing that considers how these individual components of the balance sheet interact with each other. Similarly, banks may have separate models of pre-provision net revenue (PPNR) and credit losses that fail to account for the fact that both sets of cash flows are derived from the same loans overseen by the same group of managers.

This article explores these interactions and how they may be built into a comprehensive stress testing framework. Ultimately, these interactions are profoundly important to the overall performance of a bank.

PPNR and credit losses

Suppose that you work in the home equity division of a big bank and are tasked with the job of building a PPNR stress testing model for a portfolio. You pull out all the stops and build a really nice model of future outstanding balances (a crucial component of PPNR) that takes account of house prices, interest rates, unemployment, and household income, as well as a careful representation of the effect of bank management strategy in controlling credit line size and the scale and quality of new originations. The model is parsimonious and watertight, passing validation easily. The CFO is impressed and wants to use the model both as a Comprehensive Capital Analysis and Review (CCAR) tool and to help her formulate

Could auto and credit card losses have been made lower during the recession as a direct benefit of the many missed mortgage payments? An isolated model of auto loans that ignores the mortgage market would miss this possibly important dynamic feature. A complete model would capture interdependencies between credit loss and PPNR across the consumer credit book.

alternative strategies under a variety of economic conditions. Unfortunately, the related credit loss models are built by the team in Boise, ID, and the models do not interact. The credit loss models have also easily passed scrutiny and are ready to roll in the CCAR submission.

The CFO wants to consider the strategy where, under the assumption of a strong economy, credit lines are increased and origination standards are lowered. These actions will tend to increase the volume of new account origination, while also boosting the scale of legacy loans. Revenue should be quite a bit higher under this strategy than the baseline benchmark results, where credit standards are maintained at their current levels. Under an adverse economic scenario, revenues will decline as demand for credit will be lower. It is conceivable, however, that stressed loose-policy revenues will remain higher than baseline current-policy revenues.

Does this mean that the strategy is a winner and should be implemented with gusto? Probably not. Increasing line size necessarily causes the potential loss given default (LGD) for the existing legacy book to rise; it may even have a more subtle effect on the underlying probability of default. Further, the losses derived from a higher volume of poorer quality new loans may overwhelm any observed increase in revenues. Compared with the baseline, lax standards lead to higher revenue, higher credit loss, and normally higher profitability. When adding the factor of a stressed economy, the result is an indeterminate revenue, much higher credit loss, and generally drastically reduced profitability.

The benefits of having a holistic home equity model – one that covers credit loss and PPNR in a coherent, inter-related manner – should be obvious. If the stress testing framework is used to inform the operations of the home equity loan business and thus the bank, the ability to run "what if" scenarios is absolutely critical. Of course, these questions do not apply merely to home equity loans; banks should also always build PPNR and credit loss models to be interactive.

Interdependencies between credit products

Imagine another scenario. You have just been laid off from your job and your prospects are grim. You drive home in a bad mood and find three envelopes in your mailbox. Your mortgage, car loan, and credit card payments are all due and you have insufficient funds to cover all three. You panic. What should you do?

At an individual level, the notion that the probability of default (PD) on any one of these products is independent of the PDs on the other two can be immediately dispelled. If you pay the mortgage, the car loan and credit card will become delinquent. Going delinquent on the mortgage would free up enough funds to remain current on the two other products.

At a macroeconomic level, prior to the Great Recession it seemed that, on average, people in trouble tended to favor mortgages for payment,

Figure 1 Great Recession caused the payment order to flip

Source: Creditforecast.com and Moody's Analytics

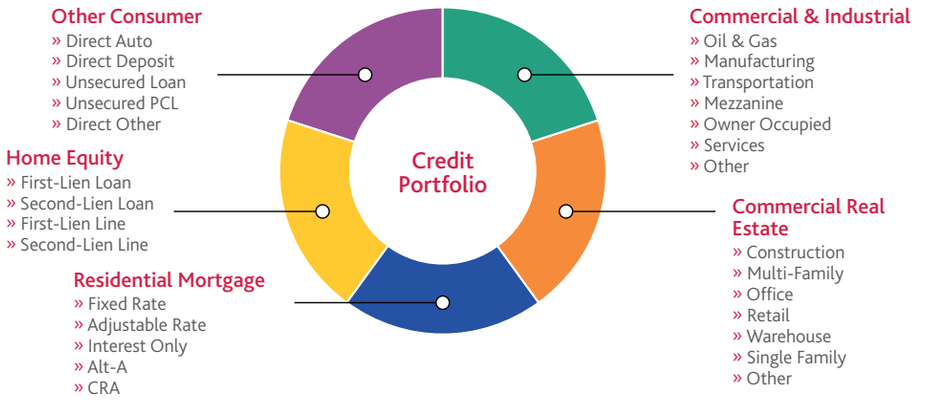
followed by auto loans and credit cards. Because falling house prices were at the root of the troubles of 2008, this determination to defend the house melted remarkably quickly. To this day, total mortgage delinquency exceeds auto and credit card delinquency by almost two-to-one (see Figure 1).

If the macroeconomic payment hierarchy was an immutable law of nature, the aggregates of auto, credit card, and mortgage loans could be safely modeled separately, despite the continuing dilemma faced by our hypothetical job seeker. As the payment hierarchy flipped as a direct result of stress, however, it seems prudent to question whether modeling consumer loan products in isolation is wise. Not paying the mortgage frees up a lot more auto repayments than not paying the credit card. Could auto and credit card losses have been made lower during the recession as a direct benefit of the many missed mortgage payments? An isolated model of auto loans that ignores the mortgage market would miss this possibly important dynamic feature. A complete model would capture interdependencies between credit loss and PPNR across the consumer credit book. One imagines that similar interdependencies exist on the wholesale side.

The other benefit of modeling across different credit portfolios is that the value of banking relationships can be explored and its effects quantified. Bankers often criticize risk modelers for failing to account for the value of relationships painstakingly built by those on the business side of the bank. Models that span different aspects of the bank could, however, start to bridge this divide.

Suppose a bank has two mortgage clients who live in adjoining identical houses. They have the same income, job tenure, and credit score; they are both paid the same and borrowed the same amount of money at the same interest rate. Now suppose the first person has everything with the bank – checking accounts, CDs, auto loans, credit cards, etc. The other person has all of these things but with different banks. Would the bank prefer the first or the second client? If the second client defaults, one upside would be that the risk is spread across a number of banks and that losses would be limited. In assessing credit risk, it seems logical that modelers should be able to obtain a tighter read on the more loyal client. Put simply, there are so many more signals about what is happening in the life of that person. There is no reason why these additional signals cannot be harnessed and the benefits and costs of loyal customers quantified; helping assess relative risk more accurately. Indeed, those who espouse the wonders of relationship banking should welcome such moves from risk modelers.

Figure 2 Credit portfolio assets



Source: Moody's Analytics

Of course, such a step is not possible unless encompassing models of the entire retail (or wholesale) book are first considered.

Links between the asset and liability sides of the balance sheet

A valid question from a modeling perspective, where credit losses and deposit balances are going to be jointly considered, is whether such forces also act at the margin. Would a small credit loss shock to a bank cause a small decline in the size of the deposit book or a small increase in the cost of obtaining funds in financial markets?

We think that it would. In a highly competitive investment and banking landscape, where investors can move their funds around with a mouse click, even small shifts in relative prices could have a meaningful impact on the demand for banking services. If we further assert that a bank's pricing power is inherently tied up with its reputation for successful money management and that this reputation would be harmed if its credit losses rose relative to the industry, it becomes easy to sketch out ways that a bank's funding costs could be affected by the scale of its credit losses.

under stress, though there are no obvious ways that an individual bank manager might respond in a bid to mitigate their effect.

While the existence of the FDIC should calm the nerves of rational investors, people often fail to behave rationally. When choosing between two equally priced, equally convenient deposit products at two different banks, perceived fiscal soundness may be a valid way to break the tie. For those whose funds are not insured, or for those who would be willing to line up to withdraw their insured deposits from a failing bank, questions of bank prudence may be a more important determinant of who wins their deposit business.

The potential for credit losses should therefore be factored into liability-side stress testing models.

In banks, head office managers do more than simply aggregate performance outcomes from individual business lines. Complex banking corporations exist to take advantage of synergies, scale economies, pricing power, and risk mitigation techniques that derive from having many such business lines under a single umbrella. If the total were less than the sum of the parts, financial markets would demand that banks be

In a highly competitive investment and banking landscape, where investors can move their funds around with a mouse click, even small shifts in relative prices could have a meaningful impact on the demand for banking services.

Two additional points should be noted here. First, we are discussing relative prices – if a bank's direct competitors suffered similar detrimental credit loss shocks, we would expect no ramifications for the deposit book of the bank in question. The observation made here concerns only the situation where one bank's credit losses rise while others' do not. The final point is that we are not talking about systemic risk. If system-wide credit losses rise as they did during the Great Recession, we would expect the overall scale of deposits to contract as confidence in the continuity of the institution of bank deposit-taking takes a hit. These systemic problems should be accounted for in modeling deposits

dispersed to create greater shareholder value. If a stressful situation occurs, presumably the advantages of corporation and coordination do not suddenly disappear. Banks should be capable of mitigating stress risks, and these efforts should be assisted by the ability of senior managers to coordinate across individual lines of business.

When reviewing the models used to address stress testing challenges, one would think that banks were completely uncoordinated collections of unrelated businesses. Each line item in the CCAR submission is estimated by a model that typically bears no relationship to the behavior of any other line item. Even within

business units, there are cases where the revenue and credit loss models used for stress testing are completely unrelated to each other. Few people have proposed models for "household" or "business" credit risk while many have used models specific to auto loans or commercial real estate to address the stress testing imperative.

If CCAR results are to be woven into the fabric of the bank, and referenced at all levels of management, this lack of coordination in stress testing models must be addressed. For this to happen, model infrastructure needs to mirror and mimic the way banks actually operate. The models need to account explicitly for the actions managers take in controlling portfolio outcomes, both within and across business lines, between revenues and expenses, and between assets and liabilities. If stress testing models remain siloed, informative intelligence may be difficult to gain in the best management responses to an adverse economic environment.

WHEN CCAR MET BASEL

By Michael Richitelli and Anna Krayn

In this article, we discuss where CCAR and Basel III intersect, with a particular focus on the data, analytics, and reporting layers of a sound CCAR/Basel III IT architecture, and why banks should address both within an integrated platform to meet, and go beyond, regulatory compliance.

On September 24th, 2013, the Federal Reserve Board (FRB) published two interim rules that scheduled the long anticipated rendezvous between the Basel III rules and CCAR / DFAST requirements. For the CCAR institutions, forecasting capital under Basel III rules is required for the next submission in January 2014.[1] And while the smaller DFAST banks get a reprieve, it is only until the 2015 submission.[2] In the interim, forecasting risk-weighted assets (RWAs) under the Basel III regime is done using systems and processes already in place – many of which rely on spreadsheets and bits of programming code.

Longer term, however, it will be critical to design IT architecture that systematizes the CCAR process, while also addressing the Basel III rules. There are a number of areas where the regulations now overlap. Compliance with both sets of regulations alone is enough of a driving factor toward further automation of each, simultaneously. In the last two years, we have witnessed how the FRB's objections to, or even conditional approval of, a capital plan can alter even a well-capitalized bank's ability to distribute capital back to shareholders, while also curtailing any plans for growth in the near-term. While the industry has spent considerable time attempting to "check the compliance box" by focusing on short-term fixes, many have ignored the potential strategic benefits, including capital optimization and organizational efficiencies which, without an integrated IT platform, will be challenging to achieve.

After a period of uncertainty following the recent financial crisis, we now have a much clearer picture of the regulatory landscape, specifically when it comes to capital planning. The instructions for the Comprehensive Capital Analysis and Review (CCAR) and the recently published Final Rule for Basel III implementation from the FRB, provide banks with the green light to accelerate plans to architect systems that address both sets of regulations.[3] Across the US, banks are working on automating the CCAR / DFAST process to make it streamlined and auditable and to lessen the burden on their staff. At most institutions, however, automation is in its infancy. Now is the time for those responsible for designing these solutions, whether they are from risk, finance, treasury, information technology, or a centralized stress testing function within the bank, to include both the CCAR and Basel III regulations in their planning and systems implementation. This includes bringing in the data and calculation engines necessary to calculate RWAs, as well as the reporting templates.

Data, data management, and Dodd-Frank

Both the CCAR and Basel III regulations begin and end with data and the management of that data. Compliance with both requires banks to compile, clean, and consolidate data from risk

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and finance systems to effectively facilitate its flow into the various models and reporting templates necessary to complete each exercise. The FRB's highly anticipated best practice guidance, Capital Planning at Large Bank Holding Companies: Supervisory Expectations and Range of Current Practice published in August 2013, clearly articulates the importance of data to a bank's management information system (MIS), as it relates to CCAR. In addition, the Basel Committee on Banking Supervision's paper on Principles for effective risk data aggregation and risk reporting further establishes the vital role that data management plays in the process. Both papers advocate for building systems that can address both stress testing and Basel III.

In their review of Internal Controls at Large BHCs, as described in the aforementioned paper, the FRB details some of the positive practices exhibited by banks with a strong MIS in place for capital planning, including the ability to:

> "…address its entire capital planning process, including the risk measurement and management systems used to produce input data, the models, and other techniques used to generate loss and revenue estimates; the aggregation and reporting framework used to produce reports to management and boards; and the process for making capital adequacy decisions."[4]

As these capital adequacy decisions will now be based on the Basel III rules, banks can easily interpolate that designing an IT architecture which captures both processes may be looked upon favorably.

The Basel Committee on Banking Supervision's guidance on data management is even more pointed:

> "A bank's risk data aggregation capabilities should be flexible and adaptable to meet ad hoc data requests, as needed, and to assess emerging risks. Adaptability will enable banks to conduct better risk management, including forecasting information, as well as to support stress testing and scenario analysis." [5]

The first step toward achieving each of these best practices is to consolidate multiple risk and finance data sources into one centralized datamart. In many banks that have embarked on this path, a data warehouse, containing a vast number of data elements that are applicable to multiple processes, feeds into a more streamlined datamart for regulatory compliance purposes. This datamart itself contains a data model to which assets and other forms of data are mapped. As a source of foundational data or "golden source of truth," it must include the granular attributes necessary for both CCAR and Basel III. These attributes include financial data on exposures, netting and collateral agreements, credit, market and operational risk-related parameters, and legal identifiers.

A platform that includes RWA calculation engines alongside the bank's loss and PPNR models, will more seamlessly and accurately produce expected loss measures, resulting in a more effective capital planning process.

The underlying data used to calculate the CCAR results, along with RWAs, is often similar. This data can be more efficiently validated, and the reports more seamlessly reconciled, if one source of granular data is the foundation for both tasks. Today, such validation tasks are done with a lot of human intervention using largely spreadsheets. The use of a single regulatory compliance datamart can dramatically decrease costs by reducing the number of redundant systems, thereby streamlining the time required to validate one set of data instead of two, as well as to validate each set of data. Down the line, additional time will be saved when reconciling multiple reports from a single data source. Finally, the data model should contain the edit checks necessary to move the process forward with a clean, validated set of data. Once a centralized data source for regulatory capital purposes has been realized, banks can begin

to achieve the FRB's and the BIS' objectives for strong MIS as it relates to capital planning. Going further, they can shift their main focus away from data management and to the analytics necessary to advance their capital plan.

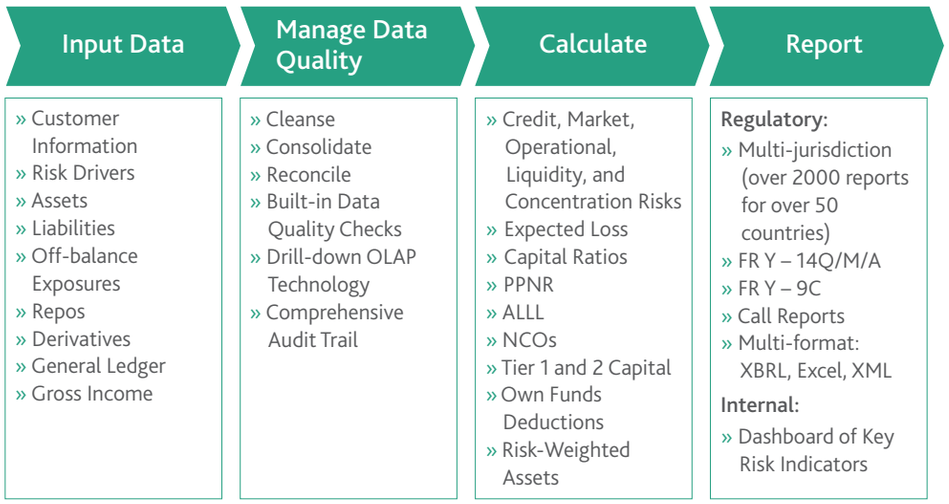
Calculations, computations, and capital

An integrated risk and finance platform, which addresses both CCAR and Basel III, will need to feature automated processes to calculate both RWAs and the stressed outputs from various models. The models will include those necessary to complete the different components of the CCAR process, including loss estimation, PPNR, ALLL, and NCO. Credit models that drive PDs, LGDs, and EADs for the calculation of RWAs (for those banks utilizing the Advanced Approach), should operate within the same infrastructure, in part, to avoid any potential miscalculation. Ideally, the underlying data layer is consistently utilized for these models, which are then run to produce baseline and stressed metrics. As with the data layer, banks should consider the benefits of including not only the loss estimation and PPNR models necessary for the CCAR exercise, but the automated RWA calculation engines for Basel III as well.

RWA projections now play a more prominent role in the revised CCAR guidelines. Banks will be required to offer more detailed information about the assumptions they use for the projections. The required information will include: income statement projections, components of on and off-balance sheet projections, and the underlying risk attributes of a bank's exposures. A controlled IT architecture that includes the data, models, and reporting templates to address these requests from the FRB will allow a bank to efficiently comply with regulatory guidance, while freeing resources to handle an advanced analysis for capital planning and stress testing.

Pro-forma RWA calculations are a key component of the capital planning exercise within CCAR. Along with the existing assets on a bank's current balance sheet, a model that produces RWAs for new business volumes is essential to completing the exercise. These new assets need to apply instrument-level Probability of Default (PD) and Loss Given Default (LGD) measures, along with instrument maturity, to arrive at the proper RWA calculation. A platform that includes RWA calculation engines alongside the bank's CCAR models, will more seamlessly and accurately produce these EL measures, resulting in a more effective capital planning process. Using an automated framework that produces RWAs on the bank's existing portfolio, while also being able to stress this output, will also greatly enhance this effort.

Figure 1 Steps to develop an integrated regulatory platform



Source: Moody's Analytics

The Basel III standardized approach in the US will necessitate a more detailed set of RWA calculations for US Banks. The introduction of the Simplified Supervisory Formula Approach (SSFA) for calculating RWAs for structured securities is one example of how banks will have to develop more precise methods for calculating their capital charges. Credit risk mitigation efforts, allowing for optimization of the bank's capital base, will also play a more important role. The ability to accurately and efficiently allocate capital eligibility criteria and collateral, as well as to calculate capital deductions, will be of even greater importance as banks look to optimize capital under the new set of rules. This is particularly important in light of the requirements for reporting (and stress testing) at different legal entity levels (a holding company in relation to a bank). Once RWAs are calculated using these and other mitigation techniques, the same set of optimized RWAs can be used within the stress testing exercise as part of ICAAP and CCAR/DFAST. Finally, the rules themselves, some of which are more complex than those introduced through the Basel I standardized approach, will evolve over time. An integrated platform, which can maintain updates to the rules, while allowing for a high level of capital optimization and stress testing, will help banks to more efficiently and effectively manage their capital planning process.

Reports, RWAs, and reconciliation

When considering an automated project for capital planning and stress testing, a number of banks are starting with the regulatory reports necessary for the CCAR submission. This top-down approach needs to consider how many of the required reports take into account baseline RWAs, along with projections across the nine-quarter horizon. There will be downstream impacts on how the data and calculation engines will need to come together to accurately populate the templates. CCAR features a number of reports that take Basel III directly into account (see Table 1).

Within the reporting layer, reconciliation is one of the more challenging tasks to overcome. The CCAR reports can be complex and must be reconciled with the FR Y-9C, the FFIEC 031/041, and the FFIEC 101 (Basel). In addition, the FR Y-14Q report, detailing the RWAs for a defined quarter, will be compared to the previous year's FR Y-14A submission, which shows the RWA forecast that was produced the year before. Any differences in these reports can be highlighted and explained more efficiently, if they are produced from the same platform. Due to the complexities inherent in not only populating the various reporting templates for CCAR with baseline and forecasted RWAs, but also in reconciling a number of the reports with one another, banks should choose a solution which can offer an integrated approach to data, analytics, and regulatory reporting. Such a solution can have added benefits as some

Table 1 CCAR reports that take Basel III directly into account

Report	Frequency
FR Y-9C - Schedule HC-R-Regulatory Capital	Quarterly
FFIEC 031 - Schedule RC-R-Regulatory Capital	Quarterly
FFIEC 041 - Schedule RC-R-Regulatory Capital	Quarterly
FFIEC 101 - Schedules A-R	Quarterly
FR Y-14A - Basel III and Dodd-Frank Schedules (total of 6)	Annually, September 30th each year
FR Y-14Q - Basel III and Dodd-Frank Schedules (total of 6)	Quarterly
FR Y-14M	Monthly

institutions are beginning to think about a return on RWA when integrating the budgeting process into the CCAR process.

The days of regulatory uncertainty, as it applies to stress testing and capital planning in the US, are over. Banks can now move from a "fire drill" stage as it relates to the CCAR exercise, to one in which an IT architecture can be enhanced and leveraged to meet multiple regulatory requirements, while also deriving business value in terms of more efficient capital planning and optimization. As financial institutions look to build out the automated infrastructure necessary to support CCAR and Basel III, it will be important to architect the data, analytical, and reporting layers so that they directly support both sets of rules. Once achieved, banks will be able to more efficiently comply with both sets of regulations, utilizing a sustainable, repeatable process that provides a measure of relief for a bank's personnel. The results will also include an accurate and optimized description of the bank's risk profile and capital – in good times and in bad.

1 Covered CCAR institutions include banks with over $50bn in assets, foreign-owned institutions with over $50bn in assets and Systemically Important Financial Institutions (SIFIs.)

2 Smaller DFAST banks are those with more than $10bn and less than $50bn in assets.

3 The Federal Reserve Board, *Federal Reserve Board approves final rule to help ensure banks maintain strong capital positions*, July 2, 2013. http://www.federalreserve.gov/bcreg20130702a.pdf

4 The Federal Reserve Board, *Capital Planning at Large Bank Holding Companies: Supervisory Expectations and Range of Current Practice*, August 2013.

5 Basel Committee on Banking Supervision, *Consultative Document: Principles for effective risk data aggregation and risk reporting*. Issued for comment by September 28, 2012, retrieved on October 18, 2013.

MODELING AND STRESSING THE INTEREST RATES SWAP CURVE

By Dr. Juan M. Licari, Dr. Olga Loiseau-Aslanidi, and Dr. José Suárez-Lledó

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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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This article presents a two-step modeling and stress testing framework for the term structure of interest rates swaps that generates sensible forecasts and stressed scenarios out of sample. The results are shown for the euro, the US dollar, and British pound swap curves.

In recent years, modeling and forecasting interest rates and yields has acquired a central role for central banks, policymakers, regulators, and practitioners. It is of crucial importance for central banks and policymakers to understand the effects of their actions on the different segments of the interest rates curve, especially the short and long ends, that will ultimately anchor expectations and transmit monetary and fiscal policy. Needless to say, that interest rate risk and the movements of the full-term structure are among the more important areas of risk management and stress testing for banks and regulators.

The academic literature has developed a non-negligible number of models of the term structure that have been later adopted by practitioners. These models could be divided into two groups whose foundation is the reduction of the dimension of the cross section of maturities to a lower number of unobserved factors that summarizes the dynamic properties of the whole cross section. However, these two approaches differ on the assumptions about the underlying determinants of the term structure as well as on their technical treatment. The first group of models streamed from the work of Vasicek (1977) and Cox, Ingersoll, and Ross (1985) are built on risk neutrality and the no-arbitrage condition.

To the second group belongs the so-called macro-finance stream of models that do not necessarily impose risk neutrality or the no-arbitrage condition but explicitly model the relationship of the macroeconomic variables with the term structure of yields and interest rates. These models stem from the dynamic version of the Nelson and Siegel (1987) work and are well-represented by Diebold and Li (2006) or Diebold, Rudebusch, and Aruoba (2004). Even though both streams started early on and seemed to not intersect, they were eventually connected by Christensen, Diebold, and Rudebusch (2009), who show how the Dynamic Nelson-Siegel models of the term structure can be extended to be made arbitrage-free and therefore equivalent to the term structure models used in the risk-neutral finance area. Therefore, this paper reviews only the methodology followed by the macro-finance approach.

This article seeks to contribute in the realm of methodology for forecasting and stress testing the interest rates curve. Although great progress has been made in understanding interest rates, and refined models have been developed, their forecasting and stress testing performance remains less encouraging. During the last decade, efforts have been made in several directions to incorporate macroeconomic factors to models of the term structure – Ang and Piazzesi (2003), Diebold and Li (2006), Diebold et al (2006), Ang

et al (2007), and Rudebusch and Wu (2008). Such efforts were initially undertaken in order to relate movements in the curve to factors that were more easily interpretable and to increase the in-sample fit. However, no attempt at forecasting or stress testing for a significant time horizon and in a dynamic environment was made at that stage.[1]

In fact, whether for business planning or for regulatory compliance, practitioners would normally need to forecast and stress test the term structure for longer horizons: two, three, or even five years. Presented here is a two-step approach to modeling and stressing the interest rates curve over long horizons. The goal is to develop a methodology that is capable of generating sensible forecasts by targeting two features of the data. On the one hand, current models appear to have difficulty in reproducing the dynamics of the spread across maturities as economic conditions evolve. In particular, it is observed in the data that under certain conditions the spread across maturities widens considerably, whereas in other environments the spread is significantly reduced. On the other hand, to the best of these authors' knowledge, no methodology for interest rates swap curves looks at the fact that certain swap rates tenor points bear a close relationship to their corresponding government yield tenor. It is the belief of these authors that it would be a desirable property that the outcome from the model reflected this relationship.

Methodology

The nature of a stress test exercise is unidirectional, as defined by regulation, modeling a risk metric as a function of the economic variables. This approach implies allowing for the economic drivers to impact the swap rates in this case, but not otherwise. More important, there is evidence from different setups that there is a significant effect from macroeconomic variables on the term structure but not so much in the reverse direction (Diebold et al [2006], Ang et al [2007], Dewachter and Lyrio [2002], and Rudebusch and Wu [2003]).

Furthermore, Joslin, Priebsch, and Singleton (2012) argue that current macro-finance models may impose strong and counterfactual constraints on how the macroeconomy interacts with the term structure. They maintain that one should model macroeconomic risks that are distinct from yield curve risks, and they propose an asymmetric treatment of yields and macro variables in which the economic factors are not spanned by any portfolio of bond yields.

In line with these observations, our proposed framework to conduct stress testing of swap rates is a two-stage process. The first stage involves forecasting the dynamic paths of key macroeconomic indicators such as GDP, money rates, and government yields under different scenarios. These projections are generated by means of a macroeconometric model that will be discussed below. The dynamics of these macro models are driven by a set of simultaneous equations built upon economic theory and econometric methods. By including some key financial variables such as government yields, this study accounts for the presence of feedback loops between the macroeconomy and the financial sector. In the second stage, a factor model is developed for the full curve of interest rates that explicitly integrates the macroeconomic drivers generated in the first stage. Because these drivers are forecast under alternative assumptions, we will be able to project the term structure of interest rates over those different scenarios.

As part of this exercise, a comparison is made between the forecasting properties of this modeling approach with other dynamic models of the term structure such as Diebold and Li (2006). That model imposes functional forms on the way the different maturities load on the factors while leaving the factors free.[2] This model does not impose any structure on either loadings or the factors.

Macroeconomic scenarios

Part of the literature on interest rates generates forecasts for the macroeconomic factors along with those for the interest rates by estimating them jointly in a vector autoregressive system. This branch of the literature often focuses purely on short-term forecasting accuracy. However, the main interest in this paper lies in

stress testing, and for that purpose conditional forecasts are considered. In short, the interest rates curve will be linked to a set of economic factors whose forecasts under alternative scenarios are derived separately.

In order to forecast macroeconomic variables, a macroeconometric model represented by the system of simultaneous equations inspired by the Cowles Commission's approach, is employed.[3] Such models are still widely used among practitioners despite some criticisms (Simon, Pouliquen, Monso, Lalanne, Klein, Erkel-Rousse and Cabannes [2012]) thanks to their practical usefulness and a balance between consistency with economic theory and actual data fit. These are nonstructural models in that they are built from many equations that describe relationships derived from empirical data, yet they are structural models in that they also use economic theory to postulate the relationships.

In the broadest sense, the macro model used describes aggregate economic activity determined by the intersection of aggregate demand and supply. In the short run, fluctuations in economic activity are primarily determined by shifts in aggregate demand, while the level of resources and technology available for production is taken as a given. Prices and wages adjust slowly to equate aggregate demand and supply. In the long run, changes in aggregate supply determine the economy's growth potential. The rate of expansion of the resource and technology base of the economy is the principal determinant of the pace of economic growth.

This model is composed of a set of equations for "core" and "auxiliary" endogenous variables. The core variables are the most important and decisive variables such as GDP and its components, trade, labor market, prices, and monetary policy. The system also includes exogenous variables such as population growth, global GDP, and global energy prices, which are forecast outside the macro model.[4]

These exogenous variables relate to foreign demand, international competitiveness and foreign prices affecting a small, open, domestic economy and are the starting point of our forecast process. Also important, they are key sources of where exogenous shocks could originate from. In turn, the auxiliary variables may be driven by the core and exogenous variables but are not allowed to determine the core variables. Examples of such second-tier endogenous variables are price deflators and industrial production.

Formally, the reduced form for the system of simultaneous equations can be written as:

$$Y_t = \sum_{k=1}^{K} \beta_k Y_{t-k} + \sum_{p=0}^{P} \beta_p X_{t-p} + u_t$$

where Y_t is the vector of endogenous variables; X_t is the vector of exogenous variables, and βk, βp are coefficient matrices. The specification of each individual equation is selected based on statistical properties, back-cast performance, evaluation of short-term and long-term forecasts, the system's stability, and parsimony. The whole macro model is also shocked with stress scenarios of exogenous or endogenous variables to ensure that the responses of the system to impulses are within a reasonable range.[5]

Forecasts are obtained from simulations on these models where regressions are used to estimate coefficients based on historical relationships and theoretical a priori. Our scenario generation begins with our baseline forecast, from which we develop the basic outlines of alternative scenarios by running multiple simulations to develop a probability distribution of economic outcomes. We then produce alternative scenarios that align with this probability distribution.

Modeling swap rates

When modeling the term structure, the correlated dynamics of the cross section of maturities plays an important role, as it allows data to be compressed into a lower-dimensional vector of unobserved factors. A very popular specification frames the interest rates in a state-space form:

The first equation models the different interest rates as a function of *N* factors, *F*, and the

$$R_t = A + LF_t + \varepsilon_t \qquad (1)$$

$$F_t = \alpha + \sum_{k=1}^{K} \beta_k F_{t-k} + v_t, \quad v_t \sim N(0,1) \qquad (2)$$

second equation models the dynamics of the swap rates curve through a number, *K*, of lags of the factors. $R_t = [r_t(1), \ldots, r_t(M)]$ denotes a (M × 1) vector of swap rates observed at time *t* for *M* different maturities; F_t denotes a (N × 1) vector of factors obtained from the interest rates data with *N*<*M*. *A* is a constant matrix that may generally be zero, and *L* is the matrix that defines how the interest rates depend on the factors. ε_t are approximation errors that will be described below, and V_t are standard regression errors. ε_t and V_t are mutually orthogonal.

The state space representation in (1) and (2) nests most of the existing models for modeling and forecasting the term structure commonly used in the literature as well as by practitioners. In our model, however, we include a set of economic drivers, E_t, obtained from our macro models, that enter the second equation as exogenous determinants of the factors dynamics:

$$F_t = \alpha + \sum_{k=1}^{K} \beta_k F_{t-k} + \sum_{j=0}^{J} \beta_j E_{t-j} + v_t, \quad v_t \sim N(0,1) \qquad (3)$$

The system (3) is then estimated as a VAR of typically order 1 (K=1). While in most of the literature the macroeconomic drivers and their relationships with the factors are estimated as endogenous variables in the VAR $F_t = (F_{1t}, \ldots, F_{Nt}, E_{1t}, \ldots, E_{Ht})$ for a number *H* of economic drivers, we focus here on the stronger directional causality from macroeconomic variables to the interest rates curve, as discussed before and reported in the literature.

Even though most modern models of the term structure consider three factors, that are interpreted as the level, slope and curvature of the interest rates curve, we will follow here more recent studies that consider only the first two of those factors, as the curvature factor tends to show little variability and almost no relation to economic variables. Although such is the most widely used approach, modern models differ in the way they extract the factors and the loadings of the different maturities on those factors. The macro-finance approach streaming from Diebold and Li (2006) and Diebold et al (2006) places structure on those loadings, leaving the factors to be determined in the following system of equations:

$$r_t(m) = L_t + \frac{1-e^{-m\lambda}}{m\lambda} S_t + \left(\frac{1-e^{-m\lambda}}{m\lambda} - e^{-m\lambda}\right) C_t \qquad (4)$$

Where r_t is the interest rate at time *t* for maturity *m*; L_t, S_t, and C_t are the level, slope and λ curvature factors; and is a parameter controlling the decay of the dependence on the factors.

In contrast, the principal component analysis does not place any structure on the loadings or on the factors, other than the latter being orthogonal. This technique extracts the factors through the diagonalization of the correlation matrix of the data—that is, they are the eigenvectors of the data covariance matrix and therefore are purely data-driven. Thus, interest rates are a linear combination of these eigenvectors (factors):

$$R_t = \Lambda' V_t^{\lambda} = LF_t \qquad (5)$$

where V_t^{λ} is the matrix of eigenvectors and Λ is the matrix of the loadings of the eigenvectors on the interest rates. PCA produces orthogonal factors by construction, therefore $\Lambda' = \Lambda^{-1}$. The set of *M* eigenvectors explains all the variance in the set of *M* interest rates. However, since our aim is to reduce the dimension of the model, we want to consider only the set of first *N* eigenvectors (factors, F_t) that would still explain most of the variance of the dataset. The choice of PCA is based on the fact that the orthogonality of the factors allows the reduction of the dimension without generating a bias from omitting some of the factors, or from modeling rates as a function of factors that are not independent. Also, using independent factors extracted from the correlation matrix will better capture the underlying structural relationships in the data, and each factor will explain a different part of the data.

In line with most of the recent literature, we find that the first two factors (level and slope) account for about 98% of the variance in the data, and therefore we will focus on the modeling of these two. This implies that $F_t = (Level_t, Slope_t)$ with N=2. Thus, estimating the curve of interest rates, R_t, as a function of these two factors — equation (1) — will always

carry an approximation error, $\varepsilon_{t,\tau}$, as there will always remain a small fraction (about 2%) of the data unaccounted for. Finally, depending on the default transformations to the matrix of loadings, Λ, applied by the different software, it might be convenient to re-estimate the linear function in equation (1), *L*, that relates the interest rates to the two factors.[6]

It is important to note that the factors extracted in the macro-finance literature are not guaranteed to be independent. Also, factors estimated through the Kalman filter may impose normality. PCA instead is a neutral technique in that sense, respecting the properties of the data whatever they may be. As a final note, this approach based on PCA is silent about the no-arbitrage condition. This article follows advice in Duffee (2012) and Diebold and Rudebusch (2013)[7] that if the no-arbitrage condition is embedded in the data, imposing it does not improve the forecasts, whereas if it is not present in the data, imposing it will create a bias. It is precisely in stressed times that no-arbitrage may be less likely to hold, and the goal is to develop a methodology for stress testing.

Estimating the dynamics of the curve

Next, the monthly data for interest rates swaps for the euro is considered. The sample period is 2000:1 to 2013:2. The cross section of maturities includes the spot swap contract rates for tenor points one, two, three, six and nine months, and forward swap contract for one-, two-, three-, four-, five-, six-, seven-, eight-, nine-, 10-, 15-, 20- and 30-year tenor points. Data have been retrieved from Bloomberg. The rates are modeled in logs in order to ensure strictly positive forecasted interest rates. Chart 8 illustrates the evolution of euro and GBP interest rates swaps over the sample period (see Charts 8-9).

Sharp upswings in the euro short-term rates between 2006 and 2008 reflected the European Central Bank's controlling of thriving euro zone's economies with tight-money policies. In this expansionary period, the spread between short- and long-term rates is very narrow. Following the peak in 2008, short-term rates fell sharply with economies in recession and policy rate cuts, while the longer-term rates formed a relatively smoother downtrend. This created a wider spread between short- and long-term rates, increasing sharply the slope of the swap rates curves, that is the difference between the long- and short-term rates. It is this behavior of the spread across maturities that other models fail to capture and what we will use as a criterion of the forecasting ability of our approach.

In this section, we want to compare the estimation and forecasting results of the macro-finance family of models, based on the Dynamic Nelson-Siegel approach, with the results from the model. Also, the results are analyzed in terms of our ability to capture both the dynamics of the spread across maturities and the alignment of the key swap rates to the corresponding yields.

Chart 10 shows that there may be significant differences between the two main factors, level and slope, extracted from the DNS model and those extracted via PCA. The time series of the DNS factors are extracted as described in equation (4) using the cross section of yields for each month, while fixing lambda (see Charts 12-13).[8]

The following figures display connections between the latent factors and macroeconomic variables, providing some intuitive support for our models for the level and slope. Charts 14 through 21 show that the level factor appears to be closely linked to money market rate and 10-year sovereign yields. They also show the relation of economic growth and the term premium (defined here as the difference between the 10-year yield and the three-month money market rate) with the PCA slope factor.

Now the dynamics of the factors are modeled in (6) following different approaches: (a) separate autoregressive integrated moving average (ARIMA) models for each factor, (b) separate ARIMA models with autoregressive conditional heteroskedasticity innovations, and (c) VAR models for the factors with the economic variables as exogenous drivers and the first lag of the factors. The following system is representative of the models tested:

$$L_t = \beta_0 L_{t-1} + \beta_1 \text{Money rate}_t + \beta_2 \text{10yr rate} + \varepsilon_{L,t} \quad (6)$$

$$S_t = \varphi_0 S_{t-1} + \varphi_1 \text{GDP Growth}_t + \varphi_2 (\text{Term Premium}_t) + \varepsilon_{S,t} \quad (7)$$

The parameter estimates signs and magnitude are mostly as expected by economic theory. Both the level and slope factors are highly persistent. The long-term and short-term interest rates are significant determinants of the level factor, which is typically interpreted as reflecting the evolution over time of the perceived medium-term inflation target. By doing this, the calibration of the short end of the swap curve to the short-term bond yields is achieved, as the money market rate moves very closely with the three-month yield rate. Moreover, 10-year sovereign yields are also incorporated as part of this equation, as they reflect the longer-term inflationary expectation, which also allows aligning the long end of the curve.

The slope factor responds with some lag to the output deviation from its trend as well as to the term premium. The latter is included in the slope equation to complete the calibration of the whole curve: the difference between 10-year and the three-month yield rates. In other words, the level is a medium- to long-term variable, whereas the slope reflects adjustments to short-term fluctuations.

Baseline forecasting and stress testing

Models of type (b) do not seem to bring much extra value that could not be captured through seasonal-type effects, so the focus on the results for models (a) and (c). As discussed in an earlier section, the loadings in equation (1) are re-estimated with a simple ordinary least squares regression of the swap rates at each maturity on the level and slope factors.[9] In contrast, the DNS swap rates are calculated using the fixed functional form associated with the factors defined in equation (4).

Given a set of parameter estimates from models (a) and (c) we compute conditional dynamic forecasts of endogenous variables (level and slope) for the period 2013:3 through 2018:3. Forecasts for the swap rates conditional on the macro variables projections under the baseline and the euro zone crisis scenarios are shown in Chart 22. The PCA approach seems to be able to replicate the historical behavior of the spread across maturities based on macroeconomic fundamentals. The PCA-based model forecasts a narrowing of the spread in the baseline scenario, which features a recovery of the economy, as the swap rates increase; that is, the swap curve becomes less steep. Under the more severe scenario, however, the spread is kept wide for the whole scenario horizon as indicated by the term premium; in other words, the curve remains quite steep for a long time (see Charts 22-25).

This approach also seems to produce a fair alignment of the 10-year and three-month tenor points to the corresponding government yields (see Charts 26-33).

Finally, results presented in Charts 34 through 37 suggest that modeling the PCA factors with a VAR or two separate ARIMA processes produces very similar results, which makes sense given that cross lags of the factors in the equations are not included.

This article introduced a two-step modeling and stress testing framework for the term structure of interest rates swaps that is able to generate forecasts that reflect two important features of the data: the dynamics of the spread across maturities and the alignment of the key swap rates tenor points to their corresponding government yields. Modern models of the term structure of interest rates are designed to produce accurate projections only to some extent for a short time horizon, thus normally failing to replicate such behavior in the data. These authors favor the extraction of factors via Principal Component Analysis, as it helps reduce estimation biases and it is free from any structure or model imposition. PCA is also appropriate for reverse stress testing, as it ensures that the mapping of a stress testing process can be inverted. Future research will be directed to the modeling of dynamic loadings as a function of the economy.

1 Some models, such as Ang and Piazzesi, feature static factors, while models with dynamic factors and macroeconomic variables perform out-of-sample exercises for only very short forecast horizons (Pooter et al [2007]).

2 The models commonly used in finance place further structure by restricting both loadings and factors.

3 Cowles Commission approach can be thought of as specifying and estimating approximations of the decision equations (Simon, Pouliquen, Monso, Lalanne, Klein, Erkel-Rousse and Cabannes [2012]).

4 The forecasts of exogenous variables, such as population projections, are sourced from international agencies, including the International Monetary Fund and the World Bank.

5 Co-integration and error correction methods are used when appropriate in separate equations.

6 Dauwe and Moura (2011) mention that "any set of vectors that can span the subspace generated by the loadings is then equivalent to the loadings without loss of accuracy."

7 Christensen, Diebold, and Rudebusch (2009) adjust the Nelson-Siegel model to make it consistent with arbitrage-free models. Although they show that it forecasts well out-of-sample, Carriero, Kapetanios, and Marcellino (2009), using a longer forecasting sample, report that the performance of the arbitrage-free DNS model is not that different from the two-step Nelson-Siegel model.

8 The main role played by lambda is to determine the maturity at which the loading on the curvature factor is at its maximum. In Diebold and Li (2006), the value of lambda that maximizes the curvature loading at 30 months is 0.0609.

9 As we mentioned before, as the principle components are independent, omitting additional components while leaving only two factors does not cause bias in the coefficient estimates.

Chart 1 EUR Swap Curve: Baseline

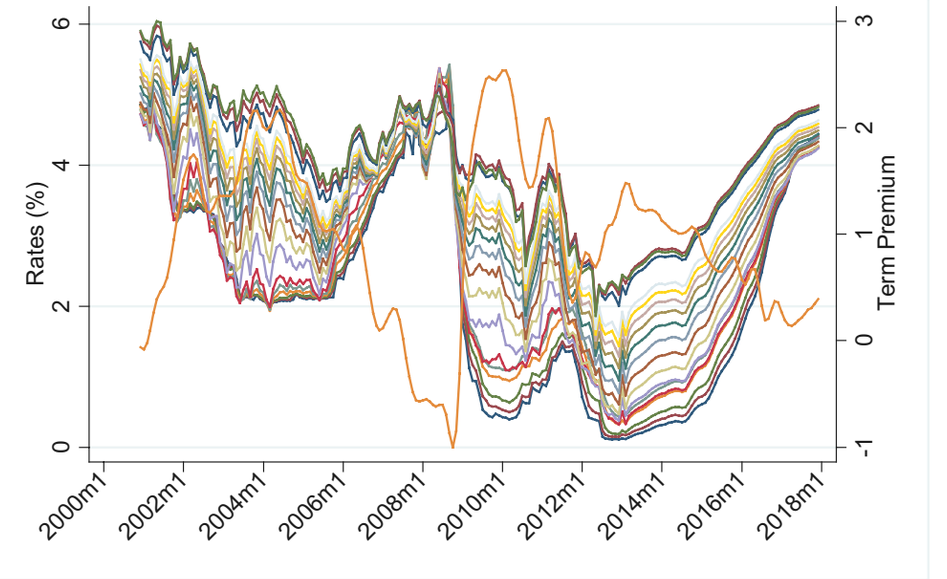


Chart 2 Euro zone GDP Growth, Alternative Scenarios

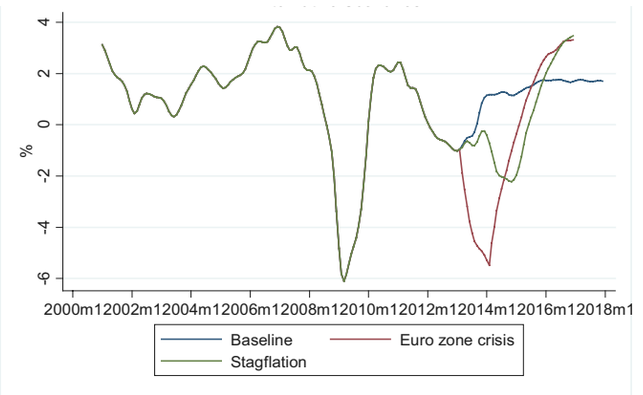


Chart 3 US GDP Growth, Alternative Scenarios

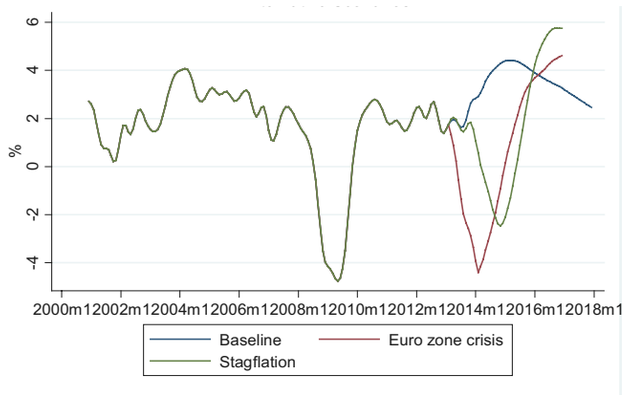


Chart 4 ECB Rate & Money Market Rate, Alternative Scenarios

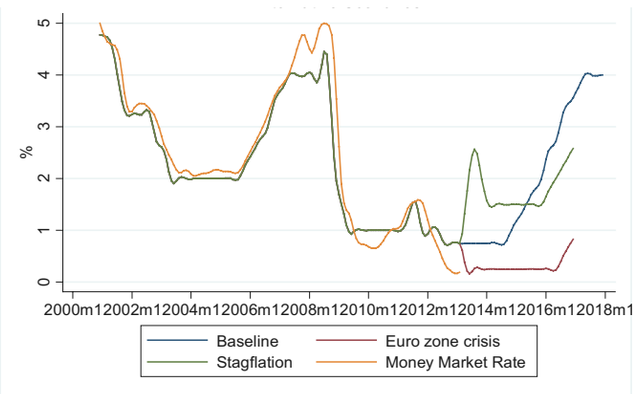


Chart 5 Fed Funds Rate & USD Libor Rate & 3-month yields, Alternative Scenarios

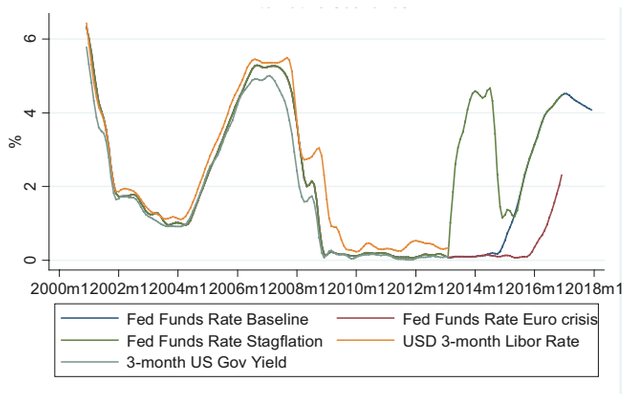


Chart 6 German 10yr Government Yields, Alternative Scenarios

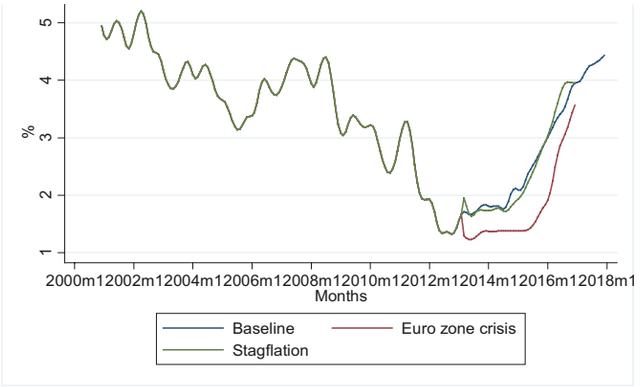


Chart 7 US 10yr Government Yields, Alternative Scenarios

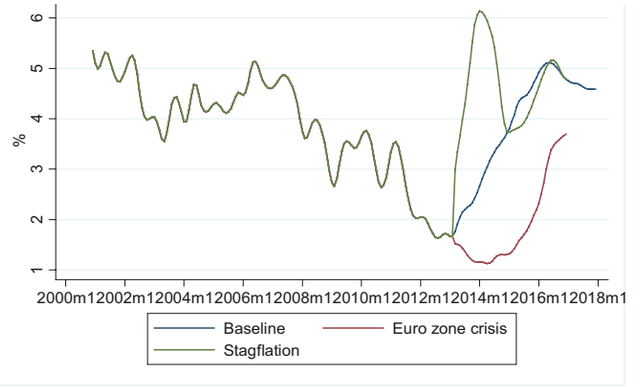


Chart 8 Euro Swap Rates, Maturities: 1M-360M

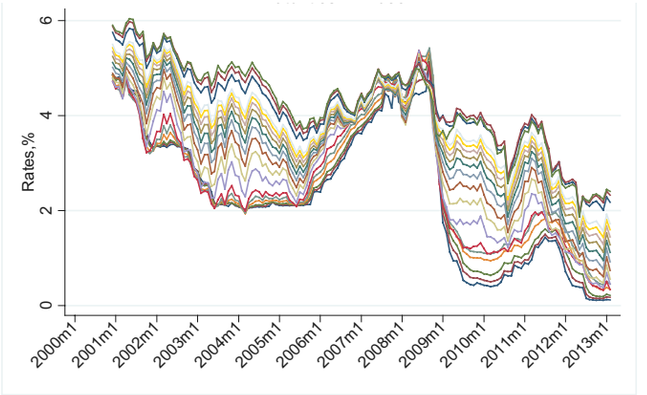


Chart 9 USD Swap Rates, Maturities: 1M-360M

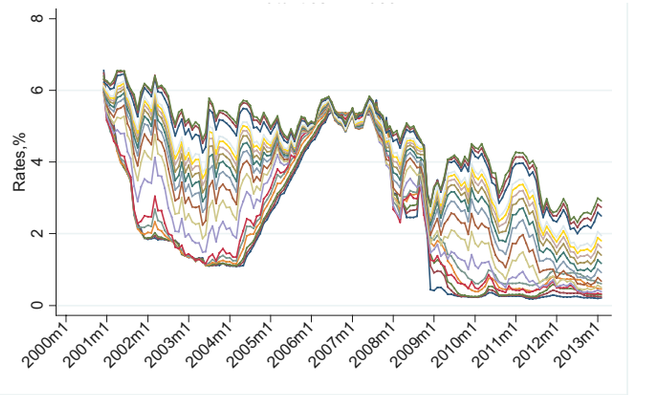


Chart 10 Level Factor, EUR Swap Curve

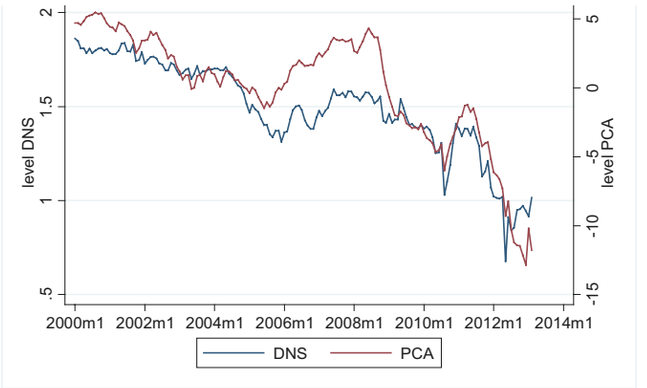


Chart 11 Slope Factor, EUR Swap Curve

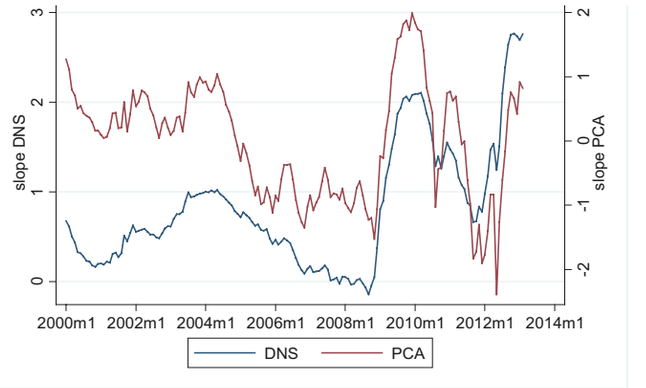


Chart 12 Level Factor, USD Swap Curve

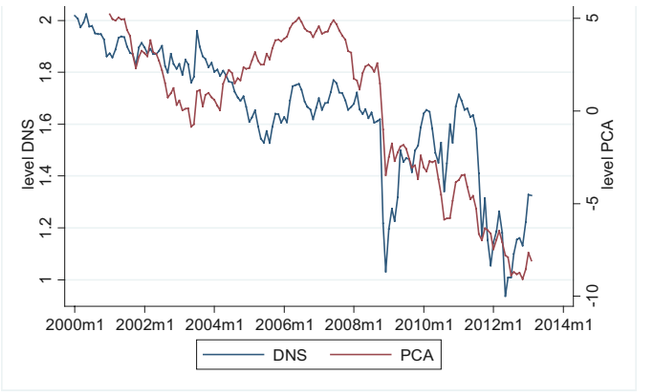


Chart 13 Slope Factor, USD Swap Curve

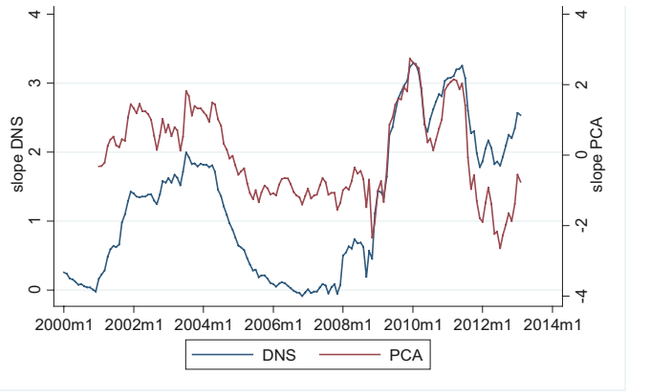


Chart 14 Level Factor vs Money Market Rate, EUR Swap Curve

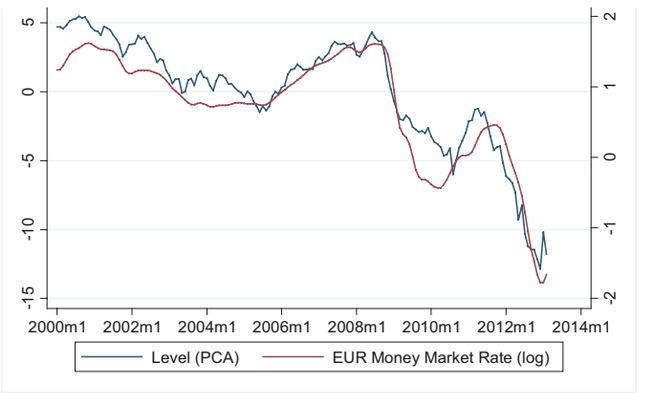


Chart 15 Level Factor vs German 10yr Yield, EUR Swap Curve

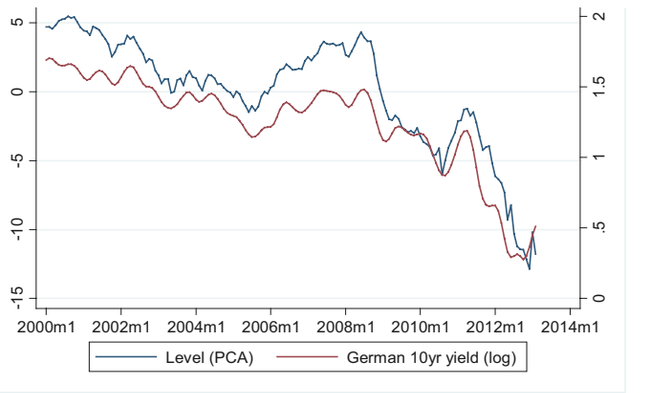


Chart 16 Level Factor vs Monetary Policy Rate, USD Swap Curve

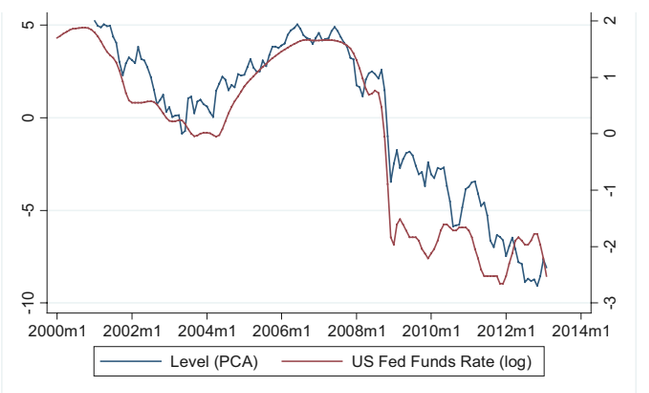


Chart 17 Level Factor vs US 10yr Yield, USD Swap Curve

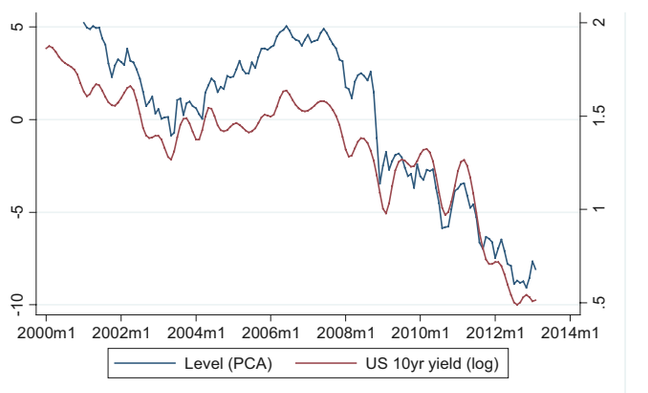


Chart 18 Slope Factor vs Euro Zone GDP Growth, EUR Swap Curve

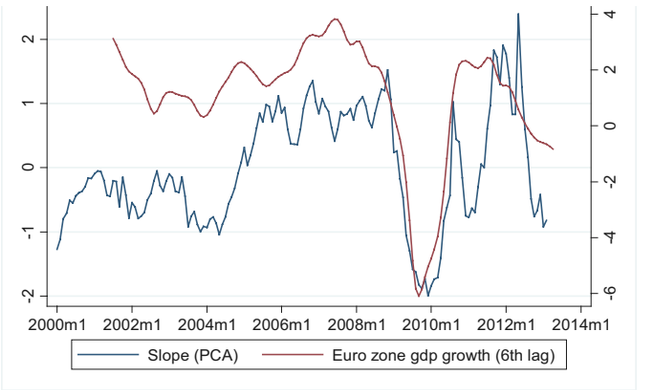


Chart 19 Slope Factor vs Term Premium, EUR Swap Curve

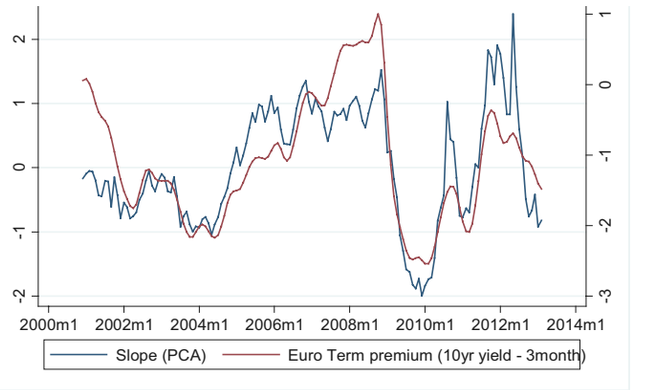


Chart 20 Slope Factor vs US GDP Growth, USD Swap Curve

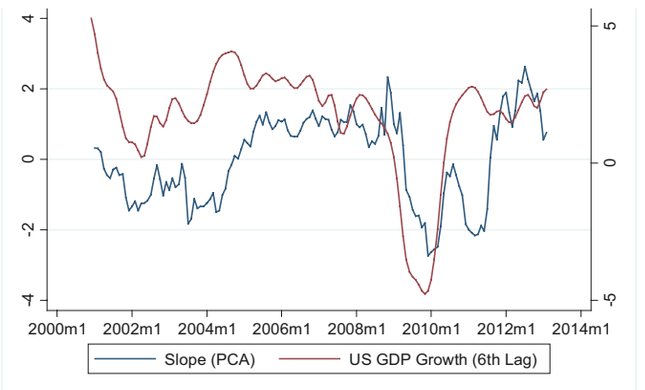


Chart 21 Slope Factor vs Term Premium, USD Swap Curve

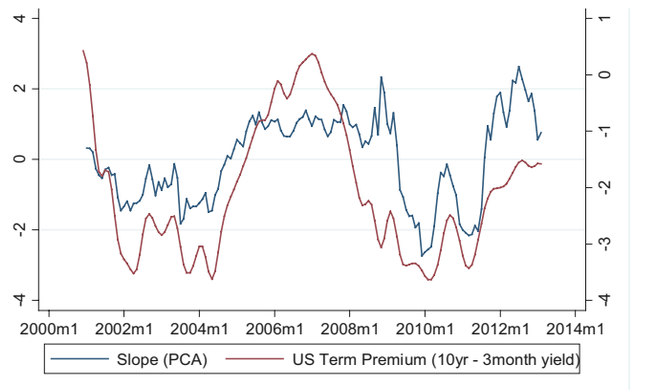


Chart 22 EUR Swap Curve vs Term Premium, Baseline

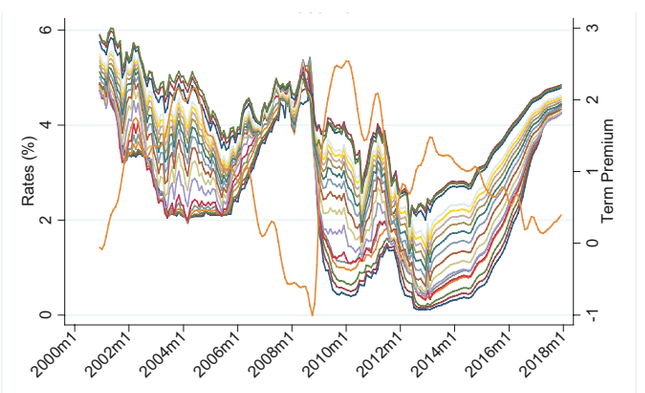


Chart 23 EUR Swap Curve vs Term Premium, Euro Zone Crisis

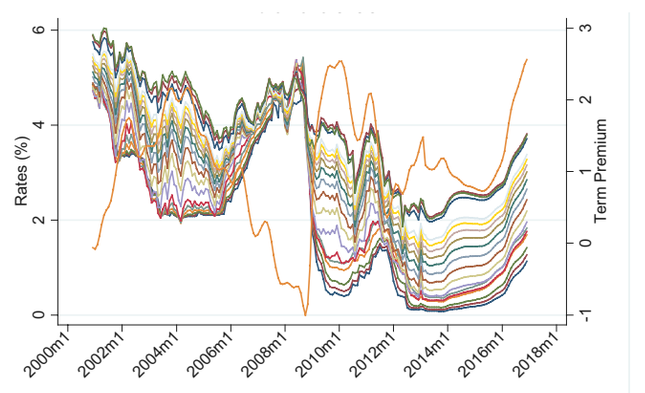


Chart 24 USD Swap Curve vs Term Premium, Baseline

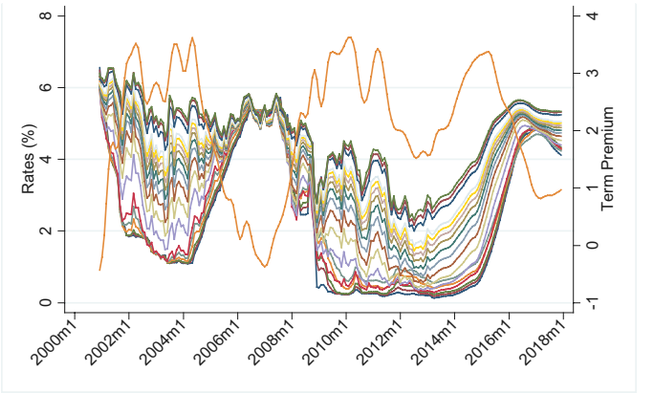


Chart 25 USD Swap Curve vs Term Premium, Euro Zone Crisis

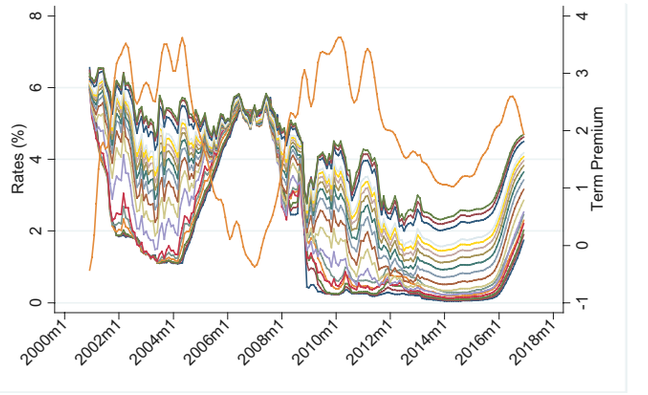


Chart 26 Baseline

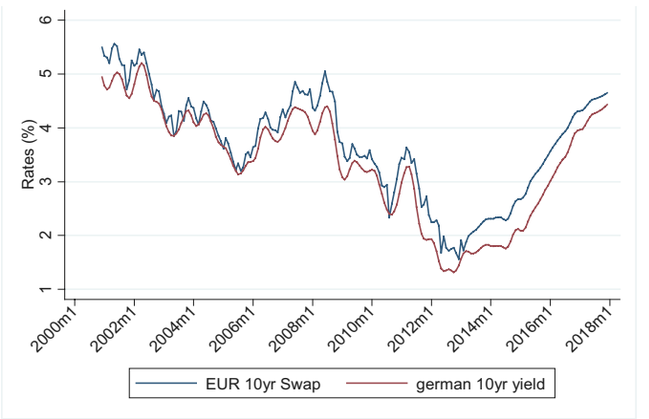


Chart 27 Euro Zone Crisis

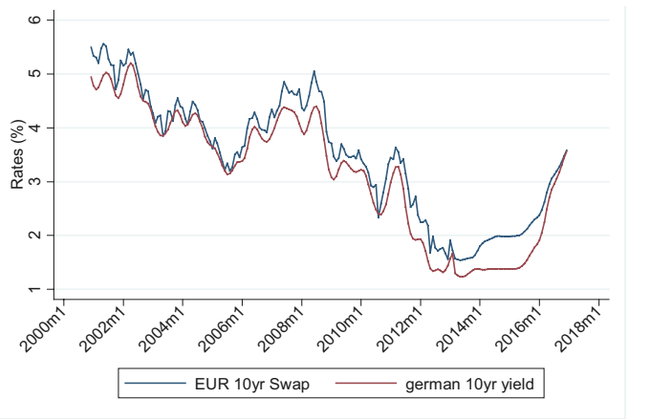


Chart 28 Baseline

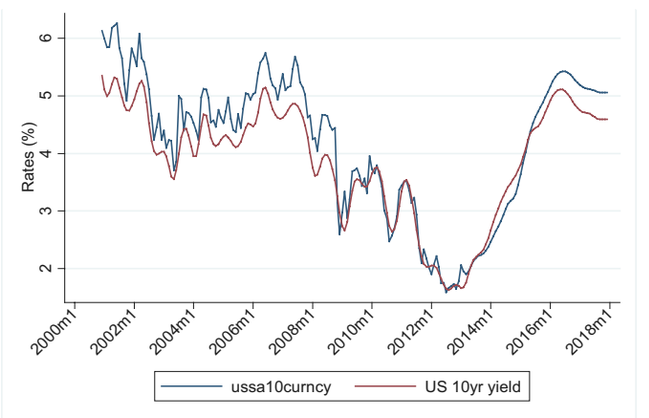


Chart 29 Euro Zone Crisis

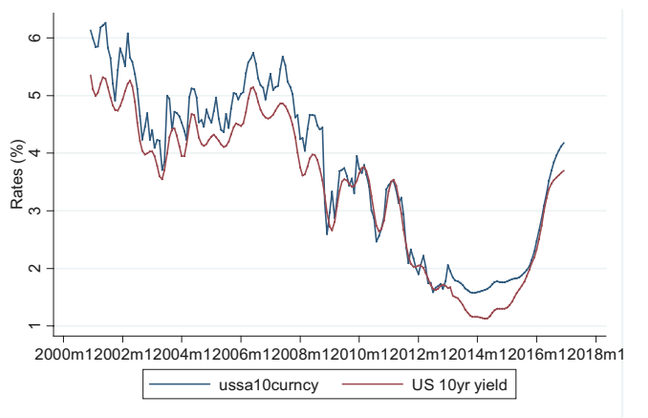


Chart 30 Baseline

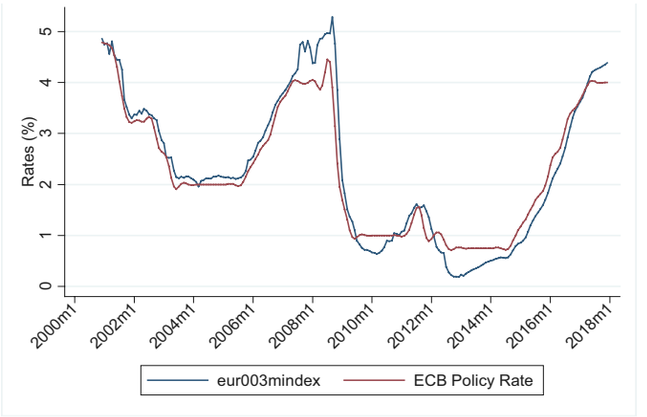


Chart 31 Euro Zone Crisis

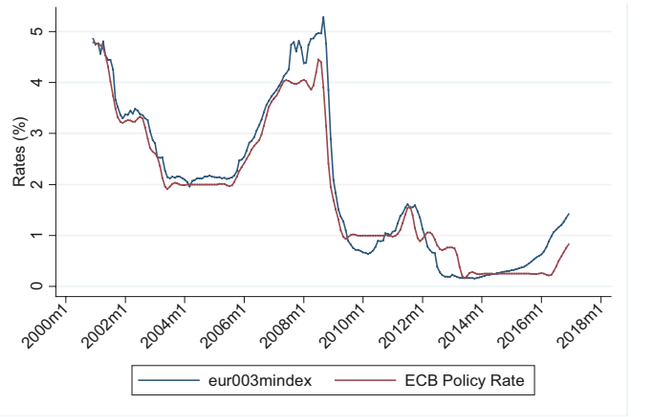


Chart 32 Baseline

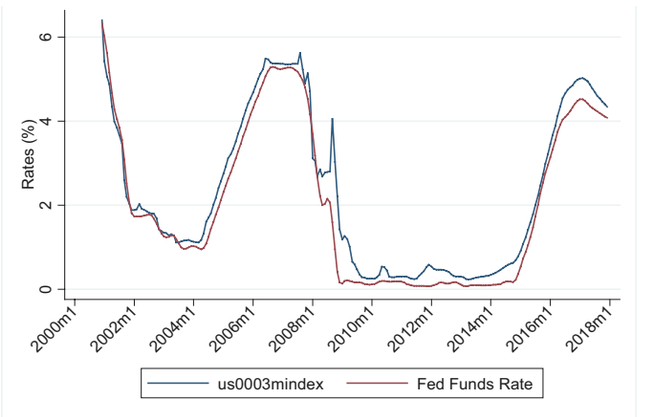


Chart 33 Euro Zone Crisis

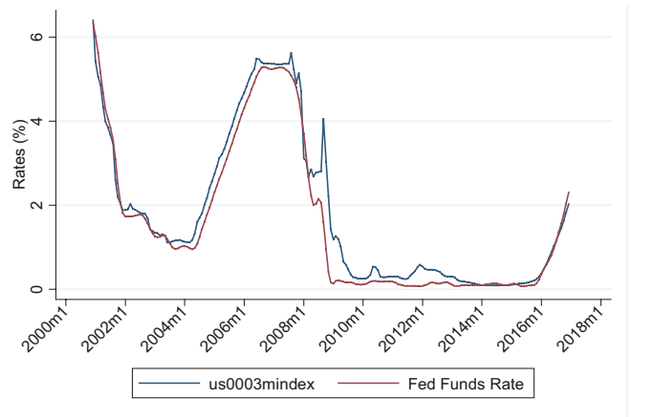


Chart 34 EUR Swap Curve vs Term Premium (VAR), Baseline

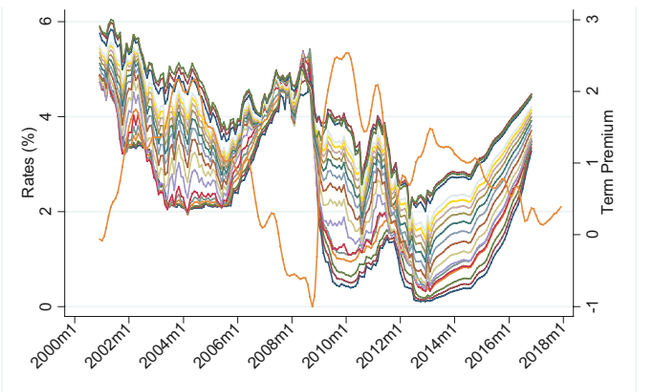


Chart 35 EUR Swap Curve vs Term Premium (VAR), Euro Zone Crisis

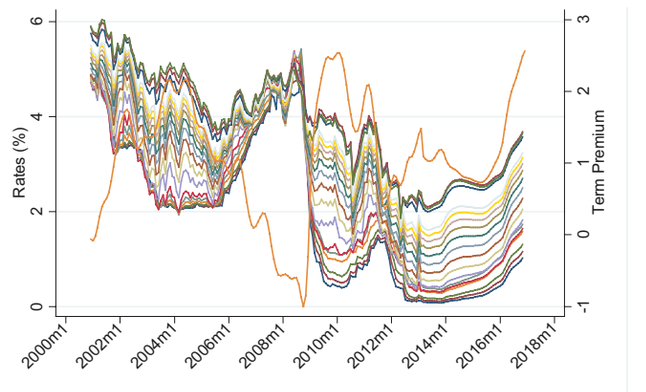


Chart 36 USD Swap Curve vs Term Premium (VAR), Baseline

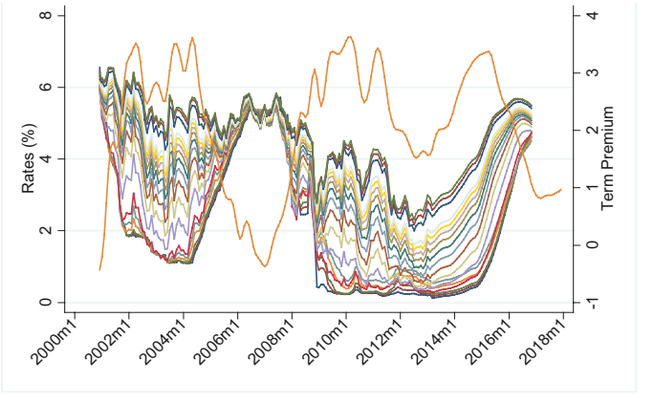
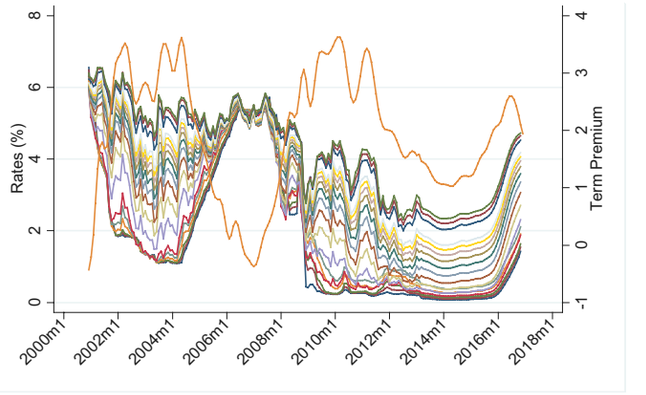


Chart 37 USD Swap Curve vs Term Premium (VAR), Euro Zone Crisis



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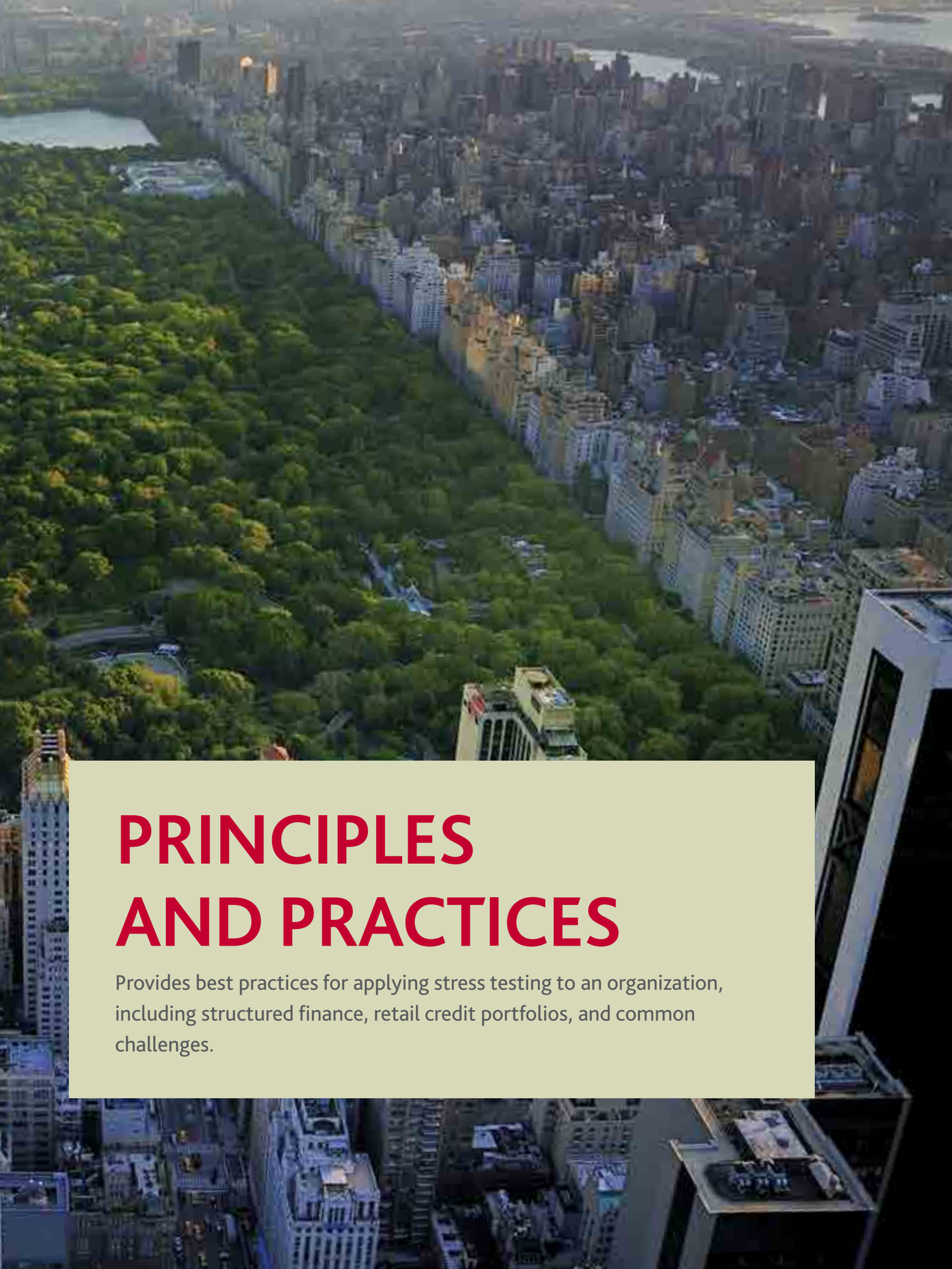


PRINCIPLES AND PRACTICES

Provides best practices for applying stress testing to an organization, including structured finance, retail credit portfolios, and common challenges.

A SINGULAR APPROACH TO APPLYING DFAST AND CCAR SCENARIOS ACROSS ASSET CLASSES (RESIDENTIAL MORTGAGES)

By Andrew Jacobs

Andrew Jacobs
Director, Structured Finance Valuations and Advisory

Andrew is in charge of developing methodologies for structured finance analysis and quality assurance with the Moody's Analytics Valuations team.

In this article, we execute the three Fed scenarios on a sample of non-agency RMBS to demonstrate how to apply one approach to both the securitized tranches and the underlying residential mortgage portfolios collateralizing the securitizations.

Calculating stressed losses on structured finance portfolios to comply with DFAST or CCAR can be challenging for many financial institutions. Consistency between the underlying asset and whole loan portfolio analyses is critical, and yet few stress testing solutions in the marketplace offer a singular solution for all asset classes.

When reviewing potential losses under the Federal Reserve (Fed) macroeconomic scenarios, it helps to have a sense of what to expect. Table 1 demonstrates the average discounted tranche loss across the three Fed scenarios through the life of the transaction. Table 2 shows the average projected loss on the underlying mortgages from the Fed's CCAR report, as well as the results from Moody's Analytics.

The numbers used in this exercise are based on a sample portfolio of 583 US non-agency residential mortgage backed securities (RMBS) tranches. In order to run the three Fed scenarios, this methodology leverages a top-down modeling framework, which enables macroeconomic assumptions from Moody's Analytics economists to automatically filter down into loan-level credit model projections. These loan-level cash flows for the RMBS transaction are then allocated to the tranches based on the legal structure (the waterfall).

Based on these figures, the findings indicate that for the Fed scenarios, the senior RMBS notes would lose, on average, about 35%, while the mezzanine notes would lose around 70%. The incremental loss between the Baseline and

Table 1 Sample US RMBS Portfolio

Average Estimated Tranche Loss		
Scenario	Senior	Mezz
Fed Baseline	33%	66%
Fed Adverse	37%	71%
Fed Severe	39%	74%

Source: Moody's Analytics

Table 2 Underlying mortgages from the Fed's CCAR report

Average Projected Loss (Severely Adverse)	
(Excludes Existing Delinquencies)	
Fed Reported	
First-lien Mortgages	6.6%
Junior Liens / HELOCs	9.6%
Projected by Moody's Analytics	
Loans Underlying Sample	7.1%

Source: The Federal Reserve and Moody's Analytics

Severe scenarios is roughly 6% to 8% on average for each of the Senior and Mezzanine tranches, respectively. We found that the underlying mortgage pools would suffer around 7% loss on currently performing mortgages. Given that RMBS pools tend to hold primarily first-liens, this estimate is not much different than the Fed's projections. As we would expect, a 7% loss on the underlying collateral translates to a lower loss for the senior notes relative to the mezzanine notes.

While averages can be useful for thinking about a portfolio, individual tranche results may diverge significantly. Table 3 breaks down the projected tranche losses into quartiles.

The variance in tranche loss is non-trivial. While the average senior note loss is about 35%, around a quarter of the senior notes in the sample lose more than 50% and another quarter lose less than around 15%. As expected, the mezzanine notes are even more volatile. Even under the Baseline Fed scenario, a quarter of the mezzanines lose almost 100%, while another quarter lose less than 35% – a smaller loss than the overall average for the senior notes. Additionally, for all three scenarios and for all tranche categories, the maximum loss is 100% and the minimum is 0%. Anything can happen given the specific performance of each deal.

Figure 1 reinforces the high variance by showing the distribution of projected tranche losses by seniority. Both senior and mezzanine notes have bar-belled distributions but the senior notes have a higher concentration in the lower losses.

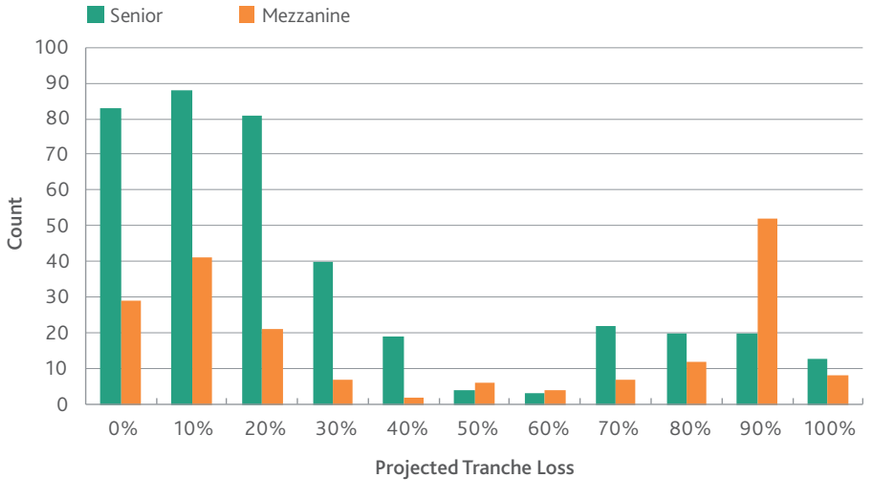
Table 4 breaks down the sample portfolio results by asset class, which highlights the variance in the individual tranche results. The overall average loss for senior notes is around 35% but there's a large dispersion based on asset class – under the Baseline Fed scenario, the

Table 3 Sample US RMBS Portfolio

Average Estimated Tranche Loss by Percentile						
	Senior			Mezzanine		
Scenario	75th	50th	25th	75th	50th	25th
Fed Baseline	13%	22%	41%	32%	83%	99%
Fed Adverse	16%	27%	49%	53%	94%	98%
Fed Severe	20%	32%	53%	57%	97%	99%

Source: Moody's Analytics

Figure 1 Distribution of projected tranche loss



Source: Moody's Analytics

average Prime tranche loss is 28% while the average Option ARM loss is 70%. It is interesting to note, too, that Subprime losses in the sample are actually among the lowest for the senior tranches. Despite having lower-quality underlying collateral, in these cases the senior notes tend to have more effective subordination due to safer deal structure to offset the riskier assets and higher current credit support.

The analysis provides some useful insights into the effects of DFAST and CCAR on credit losses for residential mortgages and related RMBS transactions.

The article first seeks to highlight the importance of using consistent modeling of mortgage losses between the balance sheet portfolio and the RMBS portfolio. The findings indicated, as expected, that the Senior tranches will generally lose less than the average portfolio loss, whereas the Mezzanine tranches will lose more. But most importantly, the exercise indicated that average loss calculations should be used with caution. Individual deals could exhibit credit losses that deviate substantially from the averages. Only a very thorough analysis of each deal would provide sufficient insight into the credit loss estimates for each RMBS tranche under the DFAST and CCAR stress testing paradigms.

Table 4 Sample US RMBS Portfolio

Average Estimated Tranche Loss by Asset Class							
		Senior			Mezzanine		
RMBS Asset Class	Sample Size	Baseline Fed	Adverse Fed	Severe Fed	Baseline Fed	Adverse Fed	Severe Fed
Prime	132	28%	28%	31%	64%	70%	75%
Alt-A	312	37%	40%	43%	58%	63%	66%
Subprime	90	21%	30%	31%	70%	76%	78%
Option ARM	49	70%	75%	74%	84%	94%	95%

Source: Moody's Analytics

STRESS TESTING FOR RETAIL CREDIT PORTFOLIOS: A BOTTOM-UP APPROACH

By Dr. Shirish Chinchalkar

This article focuses on model building from a bottom-up perspective of mortgages and home equity lines of credit to underscore the importance of loan-level analytics.

Dr. Shirish Chinchalkar
Senior Director, Quantitative Finance, Structured Analytics and Valuations

Experienced in numerical and high-performance computing and computational finance, Shirish works on the Portfolio Analyzer platform for analyzing residential mortgages, auto loans, and asset-backed securities.

The role of stress testing goes beyond regulatory requirements and forms an integral component of risk management. With the right tools, a risk manager can understand, hedge, and reduce risks in their bank's retail credit portfolio, which consist of consumer loans, primarily in the form of mortgages and home equity lines of credit, auto loans, and credit cards.

A bottom-up approach

You can perform stress testing in one of two ways – either an aggregate level "top-down" approach or an account level "bottom-up" approach. In the top-down approach, loan-level data is aggregated along a few dimensions. Models for different performance measures can be built at this aggregate or "repline" level. In the bottom-up approach, models are built at the loan level. The performance results can then be aggregated at any level of granularity. An effective stress testing program will often include multiple models using both approaches.

Modeling at the account level offers several advantages to risk managers. First, loan-level models provide capital requirements and risk assessment at the highest level of granularity. This level of detail is often useful in understanding and hedging risk. For example, loans with high capital requirements could be hedged against or traded. Risk managers can identify other dimensions of concentration risk, such as geographic risk, by determining loan-level contributions to the Value-at-Risk (VaR) of the portfolio. Second, if the portfolio is highly heterogeneous in composition, an account-level analysis allows managers to identify the outliers in the portfolio population. Often, the portfolio risk depends more on the outliers in the portfolio than on the average loan. For example, if the average Loan-to-Value (LTV) of the portfolio is 60, but a few loans have an LTV of 100, the loss of the portfolio in various scenarios depends largely on the heterogeneity of the portfolio. As the expected loss is a non-linear function of the LTV, the portfolio expected loss cannot be accurately determined by the average LTV. In cases with a large number of risk factors and their interactions, a bottom-up approach can offer a reliable means for an accurate and exhaustive risk analysis.

The complexity of mortgage modeling

There are several different types of mortgages – fixed rate loans of different terms, adjustable rate mortgages (ARM) with different fixed rate periods, underlying indices, reset frequencies, and terms, loans with Interest Only (IO) features, first and second lien loans, and loans with balloon payments. The nominal default and prepayment rates for different types of mortgages differ considerably, not only in the average value, but also through time. For example, the default rate for an ARM loan with a fixed rate period of three years is the highest when the loan is about three years old, because that is when the rate resets. On the other hand, the default rate for a fixed rate loan is the highest in the first couple of years.

There are other complexities as well in modeling defaults and prepayments. The sensitivities of

defaults and prepayments to risk factors such as the LTV or mortgage premium are dependent on the FICO of the borrower. To model this behavior, we need to consider the joint interaction of FICO and LTV, or FICO and loan amount, in the default and prepayment models. The dependence of default and prepayment on each of the model factors is non-linear. Often, the default or prepayment rate "levels off" beyond a certain value of the loan or borrower characteristic.

Loans from different vintages behave very differently. The prevailing underwriting standard at origination plays a role in determining the riskiness of the loan. Moreover, the age of the loan, the home price changes since origination, the changes in unemployment rates and mortgage rates since origination, and the interest rate at origination all play an important role in determining the prepayment and default risk of a loan.

Some high LTV loans have mortgage insurance. If the loan defaults, the mortgage insurer pays a portion of the gross loss on the loan. If a pool of loans is securitized, the mortgage insurer may insure the aggregate losses on the pool. Mortgage insurance introduces significant nonlinearities in the expected loss of the portfolio.

All these features make residential mortgages one of the most difficult products to model. Moody's Analytics has built econometric models for default, prepayment, and loss given default (LGD) using macroeconomic variables and loan and borrower characteristics. The correlation between the defaults, prepayments, and LGD of different loans is driven by the dependence on common macroeconomic variables.

Stress testing a portfolio

Portfolios can be stressed in several ways. Risk managers could increase the probabilities of default (PD) and LGD for each asset or increase the default correlation between different assets. A more intuitive and consistent approach is to stress the macroeconomic environment by lowering the GDP and home prices and raising the unemployment rate. As the behavior of the borrower depends on the macroeconomic environment, stressing the economy produces an increase in the PD and LGD of the underlying loans. The default correlation increases due to the dependence on common, stressed, macroeconomic factors.

Risk managers need tools for stressing the economy and can use pre-determined stress scenarios or the Fed CCAR stress scenarios. Alternatively, they could view the behavior of a few macroeconomic variables. Moody's Analytics has developed an approach for determining, through maximum likelihood estimation, a consistent set of values for all the other relevant macroeconomic variables. With this tool, a risk manager can create custom scenarios to stress a portfolio.

Modeling at the account level offers several advantages to risk managers. First, loan-level models provide capital requirements and risk assessment at the highest level of granularity. Second, if the portfolio is highly heterogeneous in composition, an account-level analysis allows managers to identify the outliers in the portfolio population.

The same loan-level credit risk models can be used in simulation. Given a distribution of macroeconomic scenarios centered on a baseline scenario, a risk manager can determine distributions of losses for the portfolio. They can then determine the VaR of the portfolio and the contribution to the VaR from each loan in the portfolio.

Extending stress testing to other asset classes

The loan-level models can be used not only for analyzing portfolios of whole loans, but also for stress testing RMBS tranches. In a multi-period setting, the collateral cash flows can

Portfolios can be stressed in several ways… the more intuitive and consistent approach is to stress the macroeconomic environment by lowering the GDP and home prices and raising the unemployment rate.

be generated through time under different macroeconomic conditions. The timing of these cash flows can be important when analyzing tranches of RMBS transactions. When integrated with a waterfall tool, risk managers can determine tranche-level cash flows, tranche loss distributions, and prices and expected losses on tranches.

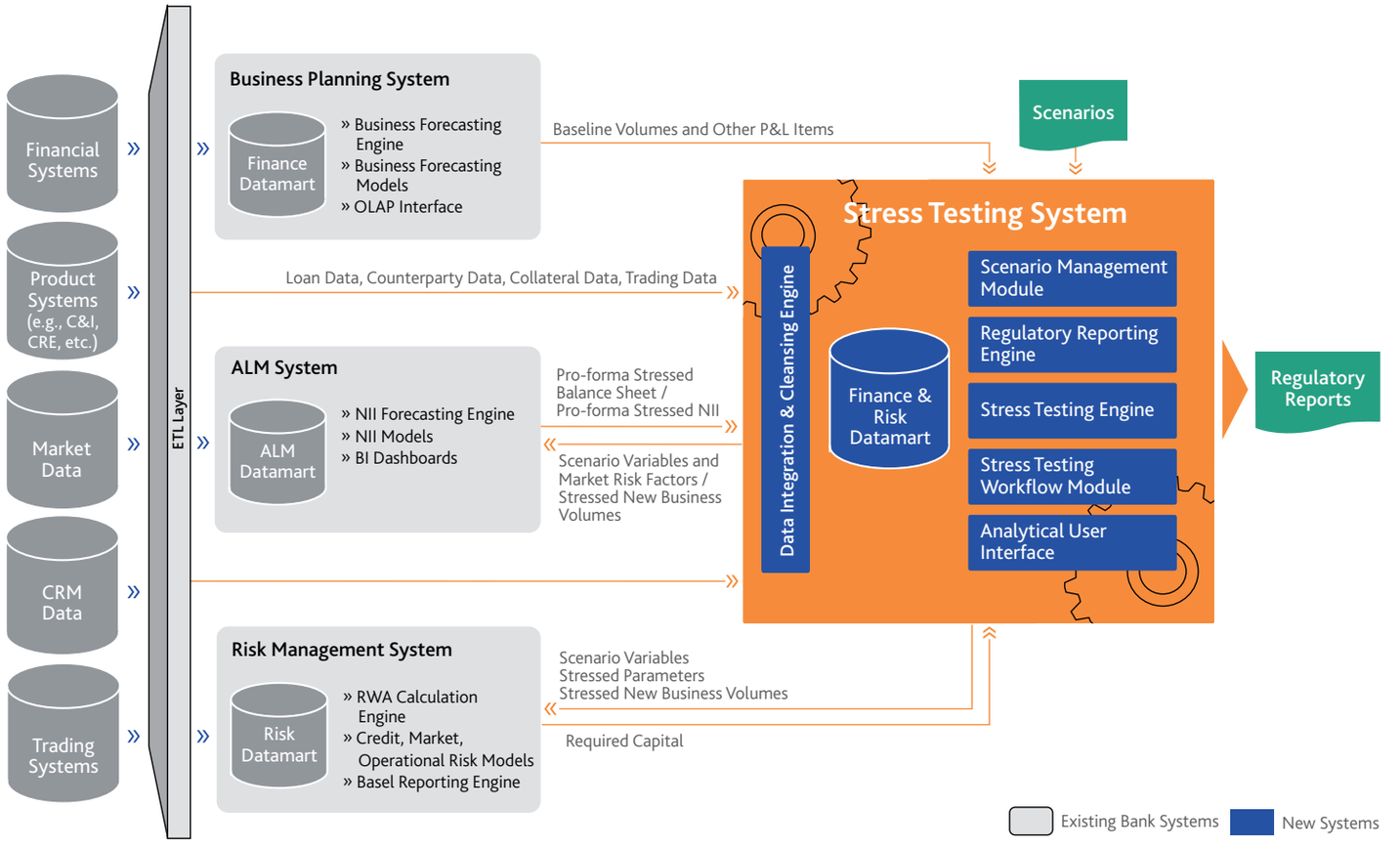
Once loan-level models are built using macroeconomic factors, the correlations between different types of consumer loans is automatically incorporated through their dependence on common macro variables. A retail portfolio consisting of all consumer loans and structured finance securities backed by consumer loans can then be analyzed in a consistent manner by stressing the same set of macro variables. This level of consistency is an important element of an effective portfolio stress testing program.

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

The following 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 centralizing all data required for the CCAR. In preparing for the CCAR exercise, many banks struggle with pulling the necessary data from various source systems deployed for originating loans, deposits, etc. In some cases, the data is missing, forcing banks to revisit the data management process in order to capture the data required by the Fed.
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. This integrated engine allows for analysis and reporting according to the scenarios put forth by the Fed as well as scenarios associated with the bank's capital plan.
3. **Scenario management module**
   This module enables bankers to define custom scenarios and leverage pre-defined macroeconomic scenarios, including regulatory scenarios. One hurdle many banks face is applying the economic scenarios to the market data in an integrated manner. Since the capital markets live within the economic scenarios, application of the scenarios should be included in the market data as well in order to be consistent with the economic scenarios.
4. **Stress testing workflow module**
   This workflow includes automated software and reporting tools designed to streamline the CCAR and enterprise-wide stress testing process. Banks face a common challenge of documenting the workflow, as well as versioning and auditing the data, so that it is consistent and persistent (by associating a time series with the data).
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 the regulators. The expectation is that over time these requirements will become more complex and will require an infrastructure to support these ongoing changing rules.

OWN RISK AND SOLVENCY ASSESSMENT (ORSA): A CAPITAL ADEQUACY ASSESSMENT PROCESS FOR INSURERS

By Brian Heale

Brian Heale
Senior Director, Business Development Officer, Global Insurance

Brian is an insurance and Solvency II specialist who has significant experience in technology solutions for the global insurance industry. He has an in depth knowledge of the life and pensions business, coupled with a comprehensive understanding of enterprise technology.

ORSA introduces a new risk and capital management environment for insurers. This article details the origins of ORSA and offers a framework for financial institutions seeking to execute an ORSA.

Designed for insurers, ORSA is somewhat similar to Pillar II of the Basel II Accord, which forces banks to "assess their overall capital adequacy in relation to their risk profile and [create] a strategy for maintaining their capital levels." The result of that Accord, the Internal Capital Adequacy Assessment Process (ICAAP), shares parallels with ORSA, as it asks for an economic capital review rather than regulatory-driven capital calculations (Pillar 1).

The ORSA in insurance

ORSA was introduced as part of the Solvency II regime in Europe, but its origins can be traced further back:

- The UK Financial Services Authority (FSA) insurance sector reforms requiring firms to develop internal models of their risks under the Individual Capital Adequacy Standards (ICAS) framework
- The introduction of Dynamic Capital Adequacy Testing (DCAT) to Boards by the Canadian Office of the Superintendent of Financial Institutions (OSFI) (1993)
- The increased use of internal models for valuation, capital, and risk management purposes by the industry and regulators alike (e.g., Swiss Solvency Test, variable annuities in US and Canada, etc.)
- Regulator recognition of a greater need for insurers to demonstrate prudent management of their business (including a system of governance, assessment of business risks, and the capital required to support these risks)

Since then, many countries outside of Europe have adopted the concept of the ORSA, either as part of a type of Solvency II regime or as a precursor to wider solvency legislation. An example of the latter approach is North America, where the OSFI and the National Association of Insurance Commissioners (NAIC) have introduced ORSA requirements to be implemented in 2014 and 2015, respectively. South Africa, Bermuda, Japan, and Mexico are also embracing insurance regulation.

One key differentiator of ORSA is "Own." As an individualized assessment, ORSA is meant to reflect the unique risk management characteristics and profile of an institution. It is a process designed to support sound risk management and decision-making within the business. In effect, the process and resulting documentation, though based on a set of regulatory principles, are unique to every insurer. As such, the ORSA cannot be implemented and fulfilled by simply generating a pre-formatted report or regulator template. ORSA is a process, not merely a report – no two ORSAs should be the same.

What is an ORSA from a regulatory perspective?

Given that ORSAs vary greatly from institution to institution, how is it defined? Figure 1 outlines the definitions used by three key regulatory bodies.

Four common elements exist within the definitions that help guide insurance companies in developing their ORSA:

Figure 1 Common definitions of ORSA

EIOPA defines the ORSA as "The entirety of the processes and procedures employed to identify, assess, monitor, manage, and report the risks an insurer faces or may face and to determine the own funds necessary to ensure that the insurer's overall solvency needs are met at all times."

NAIC says "ORSA shall mean a confidential internal assessment, appropriate to the nature, scale, and complexity of an insurer or insurance group, conducted by that insurer or insurance group of the material and relevant risks associated with the insurer or insurance group's current business plan, and the sufficiency of capital resources to support those risks."

OSFI states that "The prime purpose of the ORSA is for an insurer to identify material risks, assess the adequacy of its risk management and the adequacy of its current and likely future capital needs and solvency positions. It should serve as a tool to enhance an insurer's understanding of the interrelationships between its risk profile and capital needs. The ORSA should consider all reasonably foreseeable and relevant material risks, be forward-looking, and be integrated with an insurer's business and strategic planning."

Sources: EIOPA, NAIC, and OFSI

- Identification and assessment of all material risks
- Sufficient capital to cover the identified risks on a forward-looking basis
- A risk management framework to monitor and control risk
- A risk management culture embedded within the business to support decision making

These regulatory regimes require insurers to produce an ORSA document. However, it is clear that ORSA is fundamentally an internal process relating to how an insurer assesses and manages risk and capital within their business.

ORSA is global

Although the European Insurance and Occupational Pensions Authority (EIOPA) initially established the base requirements for ORSA, the other regulators have adopted the measures. The International Association of Insurance Supervisors (IAIS) is promoting ORSA as a key component of regulatory reform.

Another example is the NAIC in the US, which issued its Solvency Modernization Initiative (SMI), followed by the Risk Management and Own Risk and Solvency Assessment Model Act (#505), requiring large and medium-size US insurance groups and/or insurers to regularly conduct an ORSA starting in 2015. The NAIC has also issued its own ORSA manual, which sets out requirements broadly similar to those of EIOPA:

1. Description of the Insurer's Risk Management Framework, which is a high-level summary of its own risk management framework, including risk appetite, tolerance and limits, and internal controls
2. Insurer's Assessment of Risk Exposure, which details the insurer's process for assessing risks (both qualitative and quantitative assessments should be performed) in both normal and stressed environments
3. Group Risk Capital and Prospective Solvency Assessment, which demonstrates that current and future capital is sufficient to support the identified risks

The current effective date for ORSA in the US is January 1, 2015, with insurers expected to file their first ORSA Summary Report during that year. However, to achieve this, insurers should already be tracking and collecting appropriate data during the 2013 calendar year. It is perhaps worth noting that a major difference between the US and Europe is that NAIC does not specify the capital measure that should be used in ORSA, but instead gives freedom to the insurer to use whatever measure they think is appropriate.

Figure 2 is a global map with notes on ORSA regulations in various regions. Another example

is the South African Financial Services Board's (FSB) Solvency Assessment and Management (SAM) framework, which includes ORSA requirements based not only on EIOPA, but also experiences from the Canadian regulator (OFSI), the Australian Prudential Regulatory Authority (APRA), the Bermuda Monetary Authority (BMA), and IAIS Principles.

In China, the Insurance Regulatory Commission issued a second-generation solvency framework in May 2013 that is very similar to Solvency and contains three pillars – capital requirements, risk management, and disclosure – that are devised to align the capital adequacy of insurers / reinsurers with their risk profile.

THE MAIN COMPONENTS OF AN ORSA FRAMEWORK

As a unique process defined by each particular insurer, no predefined approach to ORSA exists. The ORSA framework illustrated by Figure 3 is recommended based on the current regulatory guidelines and Moody's Analytics best practices. Each of the listed elements form the building blocks of the ORSA and may be customized to meet both internal business needs and external regulatory requirements:

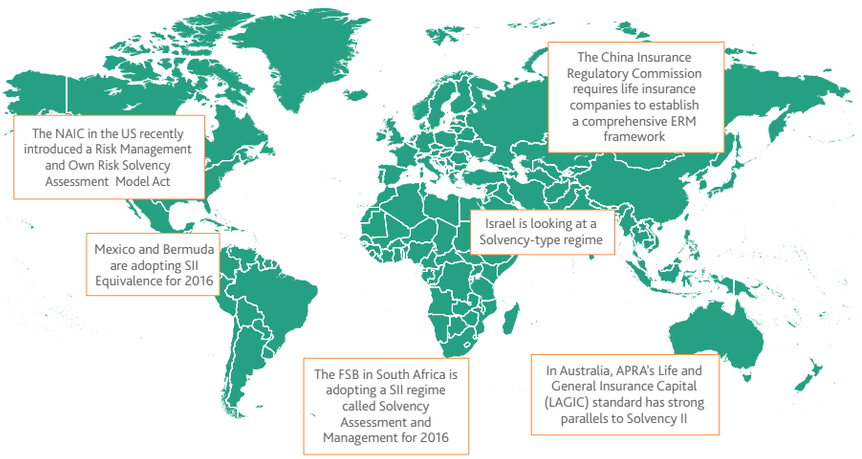
> One key differentiator of ORSA is "Own." As an individualized assessment, ORSA is meant to reflect the unique risk management characteristics and profile of an institution. It is a process designed to support sound risk management and decision-making within the business.

- Overview and processes
- Risk profile, appetite, and tolerance
- Risk identification and assessment processes, including materiality
- Methodologies and tools for risk and capital calculations
- Stress and scenario testing methodologies and assumptions
- Integrated business and contingency planning
- Integration of ORSA into capital management business as usual
- Mitigation and management actions
- Review, approval, audit, and documentation
- Key metrics

Overview and processes

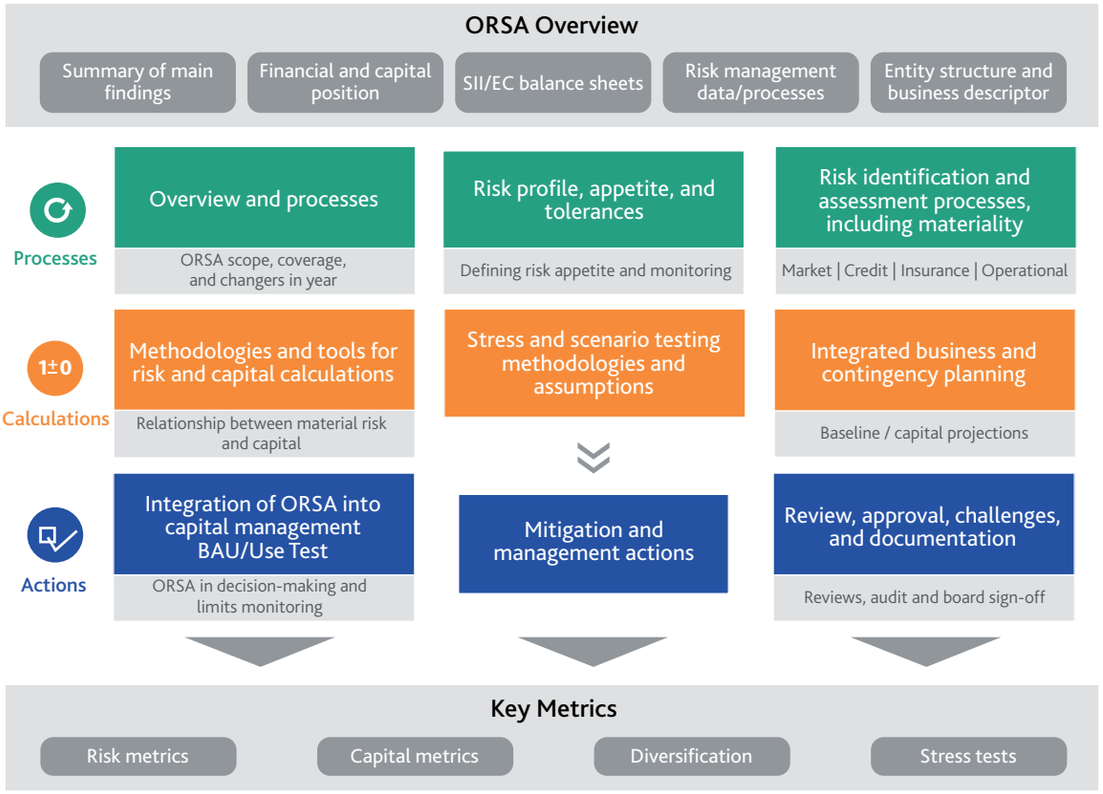
The overview establishes the scope and coverage of the assessment, enabling insurers to implement an effective and demonstrable risk management framework. Many insurers already have some form of enterprise risk management (ERM) system in place, which may need to

Figure 2 Global map of ORSA regulations



Source: Moody's Analytics

Figure 3 Moody's Analytics ORSA Framework



Source: Moody's Analytics

be extended to cover the ORSA. In particular, analytical data quality and associated practices are important to address.

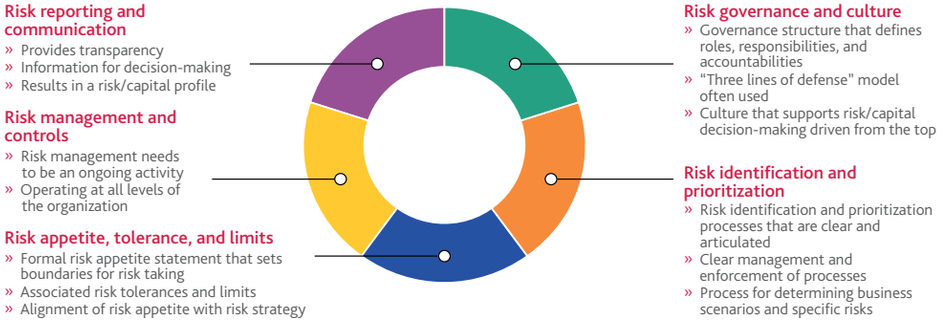
The ORSA should be proportionate in its sophistication and depth to the nature, scale, and complexity of the business. The development of a risk management culture within the business is key. Most insurers will embed their ORSA requirement within an ERM framework and operate a "three lines of defense" approach as the core of their risk management practice. Figure 4 illustrates the five main components of a typical ERM system.

Risk profile, appetite, and tolerance

From both a strategic and ORSA perspective, an insurer will have to define its risk profile, attitude, and tolerance. In many financial institutions, these factors already exist, but the ORSA will act as a catalyst to formalize and monitor them.

- **Risk profile** refers to the broad parameters an insurer considers when executing its business strategy in its market sector.
- **Risk appetite** describes the level of risk an institution is willing to assume, given the corresponding reward associated with the risk, attitude to risk, and the limits (or tolerances) within which it is prepared to operate. The appetite will articulate an institution's attitude and exposure to risk and support the delivery of strategic objectives. The risk appetite should reflect the culture of the insurer and be articulated in a way that is easily understood. Ideally, the appetite will become embedded in the organization and be used in all levels to enhance decision-making. Many insurers are establishing a risk appetite framework to assess and manage the risks they want to acquire, avoid, retain, or divest.
- **Risk tolerance** is the stated amount of risk a company is willing and able to take on in executing its business strategy. It represents the risk appetite variation on the different risk factors relevant to the insurer.

Figure 4 ERM system components



Source: Moody's Analytics

Risk appetite and enterprise-level risk tolerance statements are critical to the effectiveness of a business. Senior management should be active participants in the identification and consideration of risk/reward tradeoffs. Once established, this element in turn will feed into the decision-making process. It is also worth noting that rating agencies typically look for management to link significant changes in its risk profile with corresponding changes to their risk appetite or risk tolerance.

Risk identification and assessment processes, including materiality

Insurers should identify all material, current, and foreseeable risks relevant to their business and include them in the ORSA. This involves extending beyond the risks prescribed by EIOPA in the Solvency Capital Requirement (SCR), and includes insurance, credit, market, and operational risk.

As best practice, insurers should consider adding risk types, such as model risk, strategic risk, reputational risk, commercial risks (e.g., new market entrants, competition from different sectors), regulatory risks (e.g., ring-fencing of capital / liquidity, regulatory censure), and group risks (e.g., intra-group transactions, securities lending, etc.).

Methodologies and tools for risk and capital calculations

ORSA requires either the use of the regulatory capital measure (SCR) and/or the use of an economic capital measure produced as a result of an internal model. It should be noted that a firm's own assessment of the economic capital requirements may be a different definition than that under Pillar 1.

Additionally, a key aspect of the ORSA is the projection of an insurer's balance sheet, which includes both assets and liabilities over a three-to-five-year horizon, based on a number of scenarios.

Typically, insurers adopt a small number (e.g., 6-7) of business planning scenarios to use in their ORSA. 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. An insurer must provide details of the calculation methods used in producing capital numbers and highlight the differences between the regulatory and economic capital numbers. Methods of aggregation and diversification (e.g., correlation matrices) should also be included where relevant. Validating capital models and assessing models is an important aspect of ORSA.

Stress and scenario testing methodologies and assumptions

The scope of stress testing in ORSA is comprehensive and should include:

- **Sensitivity measures:** Measure the impact of a move in one particular risk driver and its impact on others
- **Scenario analysis:** Involves assessing the ability to absorb exceptional but plausible events with simultaneous moves in a number of risk drivers

- **Scenario analysis through time:** Is essentially capital planning simulation for stressed, severe, and optimistic stressed scenarios

Insurers should also perform reverse stress testing to identify and quantify those scenarios that could result in business failure, breach of economic solvency, breach of SCR and MCR, and other circumstances considered appropriate by senior management and the board.

Scenarios should reflect plausible events (both severe and optimistic) that may happen over the business planning projection period (e.g., 3-5 years). It can be time-consuming to derive and quantify the impact of the scenarios. However, it is insightful to go through the process of discussing possible scenarios, their financial impacts, and possible management actions.

It is important to note that the stress test program should be duly structured, validated, and documented.

When developing the stresses, an insurer may consider different types of scenarios, such as:

- "Top-down" macroeconomic scenarios capturing systematic exposure to economic and financial market outcomes
- "Bottom-up" scenarios that reflect firm-specific risk exposures arising from their strategy and operational profile
- Systematic insurance risk scenarios, such as longevity and underwriting risks

Integrated business and contingency planning

Although ORSA is largely a regulatory initiative, it should be at the heart of the insurer's business decision-making process. The ORSA should include:

- Baseline capital forecasts
- A 3-5 year capital forecast
- Contingency plans
- A description of capital planning process
- Plans on how to meet internal and regulatory capital requirements

Many insurers will most likely also use additional ORSA indicators and targets in their strategic framework, for example, to set a minimum target for SCR coverage.

Integration of ORSA into capital management business as usual

The board and senior management are responsible for ensuring that the ORSA is embedded in the business and decision-making processes. Ideally, senior leadership will also decide on the accuracy and completeness of the ORSA through direct review and reliance on the governance process.

The results of the ORSA should be used to inform and improve business decisions, business strategy, and the ERM framework. The ORSA process should also identify the major issues affecting the solvency of an insurer (or group). In practice, this means the key decision makers in the business must be provided with relevant risk management information and risk quantification approaches consistent with the ORSA. Decision-making should demonstrate what elements have been taken into consideration. A key facet of ORSA is that is should provide the board and senior management with a holistic view of risk and capital within their business.

Mitigation and management actions

Generating correct and meaningful reports is an undoubtedly important part of the ORSA and the associated decision-making process, but so too is the willingness of management to take action based on the information provided. In some situations, management actions can be pre-built into certain scenarios, so that in the event of the scenario materializing, a series of pre-planned actions are triggered. In other circumstances, actions will have to be much more reactive.

If the stress tests indicate scenarios where the solvency ratio dips below desired levels, then insurers need to develop plausible management actions. This includes hedging risk to reduce market risk exposure, transferring risk via reinsurance, reviewing product mix, potentially exiting specific products or lines of business, and raising new capital in extreme cases. These plans need to be documented and should be regularly reviewed and approved by the board.

In practice, the ORSA should continuously trigger management decisions and actions. An insurer can take, mitigate, transfer, or terminate

a risk depending on the circumstances.

Review, approval, audit, and documentation

The ORSA is the responsibility of the board and the senior management and should be regularly reviewed and approved. They are also responsible for ensuring that the ORSA is administered by personnel with the relevant skills and expertise.

The ORSA should be appropriately evidenced and documented. Some examples include methods valuing assets and liabilities, risk modeling techniques, confidence levels, and time horizons.

The effectiveness of the ORSA should be independently assessed, either internally (e.g., internal audit) or externally. This review must be carried out by different people from those performing the ORSA.

The ORSA process should by design enable entities to estimate changes in capital requirements and the economic balance sheet since the last full calculation process. A full calculation may be required if a firm's risk profile changes significantly.

Figure 5 illustrates the cyclical nature of the ORSA process, with an emphasis of some of the potential quantitative outputs.

ORSA introduces a new risk and capital management environment for insurers. It also highlights the need for a robust methodology relating to actuarial and capital modeling systems that support the business. Equally important is the analytical data fed into those systems – data quality, validation, lineage, and approvals – which all must be addressed in a data quality framework.

> Generating correct and meaningful reports is an undoubtedly important part of the ORSA and the associated decision-making process, but so too is the willingness of management to take action based on the information provided.

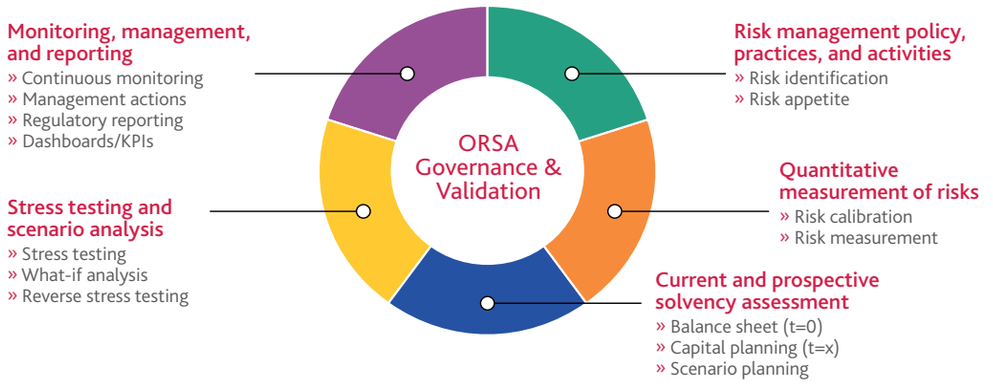
ORSA should be a continually evolving process, and while the regulators expect that the initial processes might be flawed, they will expect improvement over time.

Key metrics

The ORSA should include an assessment (quantitative and qualitative) of the own funds held, together with changes expected in stress situations. Currently, no specific obligation on insurers – solo or group entities – exists to continuously recalculate SCR, MCR, and economic capital. In reality, however, many insurers are moving to continuous solvency monitoring.

The operational consequences of ORSA will be far reaching. They will provide impetus for insurers to systematically design and use risk-adjusted performance management criteria. While regulatory-driven, ORSA presents a great opportunity for insurers to step beyond mere compliance and develop sound risk management processes that serve as the basis for informed business decision-making.

Figure 5 The cyclical nature of ORSA



Source: Moody's Analytics

10 practical tips for the success of a full ORSA program

1. Embed ORSA fully into the culture of the business and day-to-day decision-making process
2. Develop solutions and approaches that go beyond regulatory compliance
3. Ensure excellent, hands-on project management
4. Get buy-in from senior executives and the board of directors
5. Execute a comprehensive communication strategy across all levels of the organization
6. Formulate clear, accurate, and auditable documentation
7. Implement a sound data quality and governance program
8. Design and implement a dedicated stress testing and scenario process
9. Set up extensive audit and challenge mechanisms
10. Avoid underestimating the ORSA requirements

REGULATORY AND MANAGEMENT REPORTING BEST PRACTICES

By Victor Pinto and Pierre Mesnard

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Victor has more than 15 years of experience in the financial industry and currently leads the software and risk management solutions team for banking in EMEA.

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Pierre has more than 10 years of experience helping provide financial institutions with risk management solutions, including asset and liability management, liquidity risk, and capital adequacy.

In this article, we explore the impact of the rapid change in reporting, driven by regulatory and management needs, and the best practices for overcoming this evolving challenge.

One of the lessons learned from the last five years is that risk drivers are strongly interrelated. The crisis, which started with credit events in the US, triggered systemic funding issues and finally propagated to other continents and industries. In the aftermath, regulatory supervisors adapted financial regulations and aimed to create rules that better captured the risks embedded within the balance sheets of institutions, as well as to implement sound management practices.

The latest Basel III guidelines, as well as the stress testing and Comprehensive Capital Analysis and Review (CCAR) initiatives taken by the Federal Reserve, illustrate the trend of asking banks to review their risk assessment processes and to disclose much more information. As a result, regulatory reports have become more abundant, granular, and integrated.

The CCAR initiative

Aside from Basel III regulations – which ask banks to hold more capital and to demonstrate safe liquidity management practices – supervisory agencies are now defining stricter guidelines for the capital planning and regulatory templates that need to be completed by leading financial institutions. CCAR requires financial institutions to adapt their processes and systems to deliver expected results on time. Large US banks have to consider the following:

- An increasing number of reports need to be submitted to supervisors – CCAR by itself represents more than 90 FR Y-14 reports
- Reports mix information that is managed across distinct business lines (e.g., finance, accounting, risk, etc.) and systems (e.g., accounting, front office, risk, planning, etc.)
- Reports have to be submitted at a higher frequency – and more detailed information has to be submitted on a monthly basis (e.g., the ability to provide liquidity details daily)
- The same information needs to be sliced and diced according to various dimensions (information should be consistent across all dimensions) and displayed in a distinct technical format (text, CSV, Excel, XML, ASCII, xBRL, etc.)

Moreover, institutions are enhancing their processes in order to better spread risk culture across business lines. Banks are implementing the appropriate management reports to fulfill this requirement, which should both reflect risk and inform a business of that risk, enabling them to better appreciate their return compared to a global risk overview. For example, banks could implement more effective and transparent fund transfer pricing mechanisms and display more detailed grids for pricing.

With their stress testing initiative, the regulatory supervisors will collect much more information from banks. They will be able to adapt their supervisory requirements and better measure systemic risks. At the same time, regulators are investing in dedicated new systems and processes to collect detailed information, which can help them quickly adapt new supervisory requirements. Existing templates can be

amended more frequently and new templates released with short notice.

AN ARCHITECTURE FOR BOTH AUDITABILITY AND MANAGEMENT REPORTING

Data consolidation

Reports like the FR Y-14 suite or those linked to the Basel regulations, as well as the latest financial templates released in many jurisdictions, require data sourced from risk (capital indicators), finance (provisions, costs, revenues, forecasts), and from other businesses. As data is often interlinked in a common calculation process (the FR Y 14 report suite addresses global stress testing processes and capital planning for the entire balance sheet), it is impossible to produce the required data for the report without a robust data foundation. This data repository should also accommodate the need to automate the creation of more reports at a higher frequency – supervisors are asking institutions to demonstrate that they can produce their Basel III liquidity returns daily.

In addition to data and technical issues, financial institutions struggle to show they have fully mastered the entire reporting process within their organizations. They need to more frequently provide reports for any solo and consolidated entity, and to more supervisors. This challenge is exacerbated in recent reports, like CCAR/FR Y 14 and DFAST, that require banks to access, validate, and reconcile data across their enterprise and to slice and dice it at any consolidated level and according to any of the standard accounting practices.

The current reporting process at many financial institutions is fragmented into reporting silos – each area with its own database and tools to produce its own regulatory reports. Regulatory reports for credit risk, own funds disclosure, liquidity risk, and stress testing are managed by each corresponding department with its own distinct tools. Even though this approach may work with many adjustments and reconciliation patches, it is ultimately limited. After implementing numerous tactical solutions, financial institutions subject to increasing reporting pressures should now invest in a centralized and comprehensive data repository that can gather all the necessary data.

A consolidated dataset is only as good as the quality of its data. It is essential that all data is validated as it is imported into the central repository, which ensures there are no errors, missing data, and inconsistencies, and that the quality of the data, such as its age, meets a bank's overall reporting requirements. A central repository can, as part of the data management process, ensure data quality via centralized editing or updating capabilities. This repository also has centralized business rules that will enrich data to meet reporting criteria.

> Working in silos may give responsibility and independence to the individual areas affected by the reporting requirements, and even gives the impression that it is a better and faster way to respond to the regulations. In the long run, however, reporting silos offer a poor response to the often rapid evolution of the requirements.

Data aggregation

Even though the industry is moving toward harmonized regulatory rules and templates (e.g., European banks have to comply with a common EBA FINREP and COREP), financial institutions with subsidiaries in many countries face the additional challenge of producing an increasing number of reporting templates. Most of the time, however, the underlying data used to produce the reports is the same. Therefore, financial institutions should implement aggregation techniques to facilitate an optimal reporting process and to reuse intermediary results as much as possible.

Infrastructure should incorporate the appropriate data points (aggregation rules) shared among several templates. When building

the aggregation rules, firms should consider a global view (capital planning, liquidity, risk, etc.) so that the data points easily match the detailed reporting requirements. Well-defined data points ensure consistency and that all validity checks will be passed.

Reports publication

Once the data is aggregated it should be "pushed" to the reporting templates, which requires a solution that can embed and maintain the full set of templates. The results of the aggregated data will then directly populate the corresponding templates, necessitating that banks map the related data points and cells (or sections of reports). The gap between the "aggregation" and "report publication" phases provides flexibility and can allow firms to check the figures once they are generated and before they are published. New templates can then quickly be adopted as each step is well identified, and can be tailored or reused for new requirements.

Moreover, having a dedicated logical link between aggregation rules and publication rules eases the disclosure of desired (sub)sets of reports, which can then be published under the expected technical format.

Auditing reports

The ability to audit the final publication, as well as intermediate results, became more important due to the increasing scrutiny by regulators of financial institutions' data.

Whether a single cell is altered or a comprehensive data patch is applied, auditors, security staff, and regulators must be able to identify and manage the changes so that the data maintains its integrity.

The optimal solution must allow managers to quickly and easily drill down into the results to gain insight into the reports and their business, such as risk and finance details, so they can better recommend strategic options for their business. This capability also helps banks respond quickly to inquiries from regulators about their results, reducing the resources needed for compliance.

THE IMPACT ON BUSINESS PROCESSES AND THE REPORTING INFRASTRUCTURE

Process automation

Alongside the automated data consolidation and the calculation of the results, the reporting solution should also seamlessly integrate regulatory reporting to create a comprehensive, automated, and consistent end-to-end process. Automatically populating the reports, by leveraging built-in reporting templates, overcomes the significant challenges of reporting CCAR results, as well as some Basel returns. This approach also allows the straightforward updating of reports as the regulatory requirements develop.

These templates should cover all the reports needed by regulators, including both core and non-core reports, on a group and solo basis. The solution must also manage all other regulatory reports to ensure consistent results. This encompasses Basel III Pillar 1 and 3 reports, stress testing reports, national regulator reports, and potentially internal business reports. Leveraging templates across all reports can enable banks to effectively provide an accurate and consistent picture to all their regulators.

This approach can also have significant benefits for the business. It can provide a bank's management with a single, integrated, and reconciled perspective of its risk and financial positions so managers can make fully informed strategic business decisions.

Workflow

Consolidating data, calculating results, and submitting reports have become highly complex. Large institutions are handling several consolidation levels, accounting practices (US GAAP, IFRS GAAP, etc.), regulations, and increasingly more templates. Smaller institutions are facing more complex reporting demands that can strain small reporting teams. Meeting this complexity without increasing resources is a challenge that requires an automated management of the full process.

The process also considers the concrete steps currently handled manually, such as changes and amendments in raw data, aggregated data, and

in final reports. The amendment processes need to be carefully controlled and audited, so that a bank's management can be assured that what they formally submit is a true reflection of its financial and risk position.

Central to this is an automated change approval process that both controls and records who can make and approve changes. Automation ensures speed and accuracy, and can be leveraged to provide management control and audit capabilities to highlight what changes were made and on whose approval. This audit capability has now become a requirement for many regulators.

The same techniques that foster optimal regulatory reporting also enable improvements to management reporting, especially the creation of a centralized data repository. The coherent combination of data from different sources is the cornerstone of any good management reporting.

THE RECONCILIATION CHALLENGE OF FINANCE AND RISK REPORTS

One of the most important aspects of the regulatory reporting frameworks evolution is the integration of redundant data from different sources and different areas. Reconciliations within the same area, risk management for example, can be performed without major challenges, as in most cases the data sources are consolidated in the same data repository.

On the other hand, when it comes to reconciliation across different areas – regulatory reporting (e.g., FR Y-9C) and financial reporting (e.g., 10-Ks, 10-Qs) for example – firms may encounter a situation where the reports are produced by different departments using different tools. This is not necessarily a problem for the individual production of the reports, but it becomes cumbersome when banks need to reconcile the data between them.

Globally, regulators are increasingly scrutinizing the low-level data of the regulatory reports. This involves also ensuring that the same data from two reports is identical, such as provision amounts between risk and finance reports.

To cope with these reconciliation challenges, banks have been investing in teams that work exclusively on the process of reconciling risk, finance, and ledger data. Efficiently reducing the workload of reconciliation teams requires banks to centralize all the reporting data on the same platform, enabling the automation of the reconciliation process. The process becomes more optimized not only when the data repository is unique, but also when all the reports are produced by the same reporting tool or system.

LEVERAGING REGULATORY REPORTING TO BUILD MANAGEMENT REPORTING

The decision to invest in a centralized regulatory reporting platform with a consolidated data repository, even though it reduces the amount of manual work, is often difficult to make for financial institutions.

Management reporting changes parallel the increased requirements of regulatory reports. The financial crisis has required management to be able to quickly obtain information about exposures and other measures. Typically, one of the most important questions that management or internal reporting should answer pertains to the total exposure of the group to one client, group of clients, country, industry sector, and so on.

Other important features in management reporting are:

- Processing of high volumes of data
- Having drill-down capability
- Requiring multi-user capability

The same techniques that foster optimal regulatory reporting also enable improvements in management reporting, especially the creation of a centralized data repository. The coherent combination of data from different sources is the

cornerstone of any good management reporting.

Moreover, for consistency purposes, it is critical that the management and regulatory reporting platforms share the same data; otherwise, yet another reconciliation process would need to be implemented.

Increasing regulatory reporting requirements and the reduced timelines for the financial institutions to adopt those requirements can lead to the main pitfall – managing the reporting processes in silos. Working in silos may give responsibility and independence to the individual areas affected by the reporting requirements, and even gives the impression that it is a better and faster way to respond to the regulations. In the long run, however, reporting silos offer a poor response to the often rapid evolution of the requirements, such as:

- New reporting templates that require changes in different systems, handled by different areas
- Regulatory-imposed reconciliation and validation checks that become more complicated

In a world of more numerous and more complex reporting requirements, it is critical that this subject is handled by an independent department, across all functional areas of the financial institution, and with the decision power to build its own data infrastructure and reporting tools.

1 Pierre-Etienne Chabanel and Graham Machray, *Integrated COREP and FINREP Reporting: A Best Practice Framework*, October 2013.

2 Federal Reserve Board, *Comprehensive Capital Analysis and Review 2012: Methodology and Results for Stress Scenario Projections*, March 2012.

3 Bank for International Settlements, *A global regulatory framework for more resilient banks and banking systems - revised version*, June 2011.

STRESS TESTING IN THE US: WHAT HAPPENS NEXT?

By Greg Clemens
Contributor: Thomas Day

This article provides an update on the future of the regulatory stress tests and their industry impact, and how banks can best address the challenges to create an optimal program that generates business value.

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As a member of the Stress Testing Task Force at Moody's Analytics, Greg helps clients automate their stress testing processes – providing insight about architectures, data management, and software solutions for risk management.

The stress testing storm

The wind continues to blow, the waters churn, and the stress testing storm rages on. More and more banks are being pulled into the fray. With regulations and requirements continuing to roll in, the risk, finance, treasury, and IT departments at banks are working towards greater collaboration on finding the best course forward.

Given that stress testing in the US is here to stay, the question on everyone's mind is "what's next?"

Which way is the wind blowing?

The greatest forces driving stress testing throughout the banking industry are the regulatory-mandated stress tests – principally the Comprehensive Capital Analysis and Review (CCAR) and Dodd-Frank Act Stress Test (DFAST) exercises. As banks prepare for the third year of the annual CCAR process, there appears to be little reason to expect much change for the foreseeable future.

In a recent statement, William Dudley, President of the Federal Reserve Bank of New York, said that the Fed is unlikely to change course anytime soon as they see signs that the US economy is improving, but that there are strong factors slowing down the speed of the recovery. Dudley said, "We must push against these headwinds forcefully to best achieve our objectives," as the US has yet to show "any meaningful pickup" in momentum.[1]

Given the status quo of the economy, it is unlikely that regulators will soon relax the CCAR/DFAST annual and CCAR mid-cycle mandates.

As for the makeup of the scenarios in the exercises, aside from incremental tweaking, there should not be significant change:

- Generally speaking, the largest banks have managed to perform the required tests for the first two years
- Regulators are reluctant to make significant changes to the structure of the scenarios, as they would lose the ability to make year-over-year comparisons of the results

That said, the mid-cycle stresses contained several interesting idiosyncratic features that point to an increased focus from the industry on tailoring stress scenarios to their own business models and risk exposures.

Finally, from a political standpoint, one of the few things members of Congress on both sides of the aisle agree on is the need for continued regulatory supervision of the financial services industry. Here is yet another reason that stress testing regulations will stay as is, or increase. Pressure for improved analytics, governance, and infrastructure, and the continuing stream of regulatory "Matters Requiring Attention" (MRA), will continue to drive banks to seek better and more comprehensive practices.

On the horizon: Basel III and liquidity risk

As Basel III approaches, regulators will introduce two components to guard against liquidity risk: the Liquidity Coverage Ratio (LCR) and Net Stable Funding Ratio (NSFR). The requirements of these two ratios will ensure that banks hold enough high quality liquid assets to survive stress periods and have secure sources of long-term funding.

Similar to the CCAR/DFAST exercises, these measures aim to address the problems that caused the financial crisis by offering more insurance against the possibility of major bank collapses. And for banks to address the liquidity risk requirements, they must carry out more frequent and rigorous stress tests and scenario analyses to ensure they can survive extreme market conditions.

The evidence of the brewing liquidity changes can be seen with the September 19, 2013 release of the proposed Complex Institution Liquidity Monitoring Report (FR2052a) and its less complex twin, the Liquidity Monitoring Report (FR2052). With these new monitoring reports, the Federal Reserve continues to take a somewhat different, and much more active approach, than some international regulators and the Basel Committee pronouncements.

As with the CCAR/DFAST exercise, it is likely that the foreign supervisory authorities will follow a similar path around liquidity risk. This is perhaps more likely given that, like the stress tests and DFA Section 165 enhanced prudential standards, the new liquidity monitoring standards apply not only to domestic banks, but also to foreign banking organizations. Moreover, with the December 2012 issuance of SR 12-17, *Consolidated Supervision Framework for Large Financial Institutions*, the Federal Reserve has established, as a core supervisory principal, enhanced capital and liquidity management to increase the resiliency of banks and the broader market.

How CCAR-worthy are banks?

During the first CCAR exercises two years ago, banks cobbled together largely manual processes and Excel-based data to run the tests they reviewed with the regulators. Slowly, firms began realizing that they need to streamline and automate their stress testing processes to be effective. They also understood that integrating and bringing consistency between and across the risk, finance, and treasury operations business lines are critical.

Figure 1 provides an overview of the maturity levels in stress testing. Most banks have launched some form of a stress testing program; yet, many still have not advanced past the "Responding to regulation" stage of stress testing maturity.

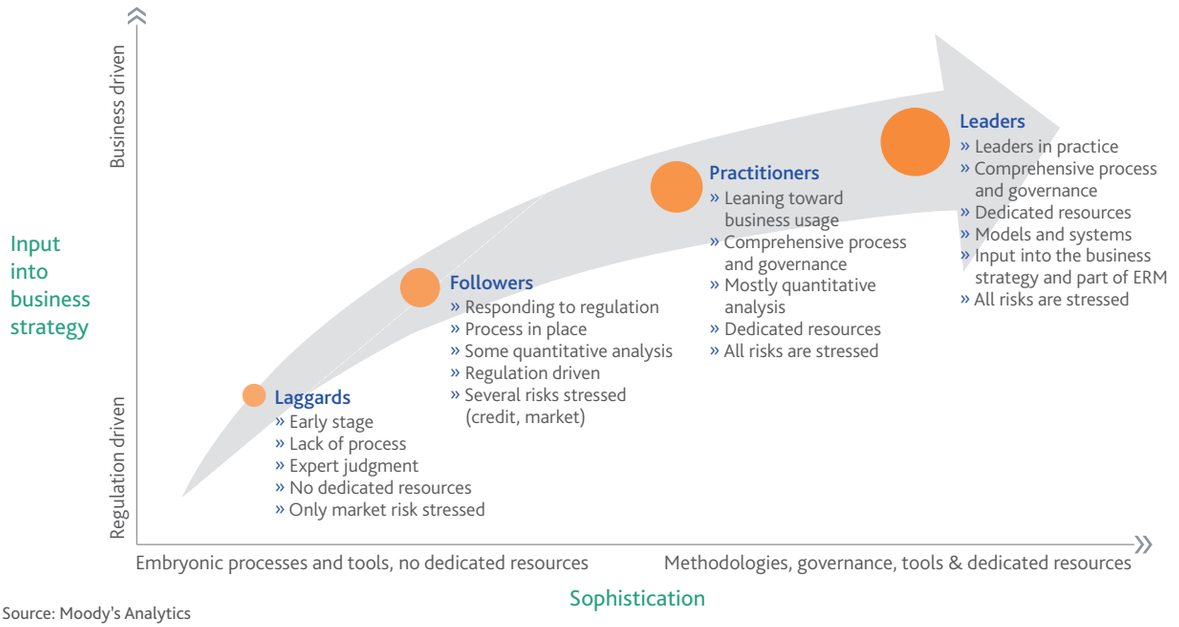
How can banks address their stress testing challenges?

Meeting the CCAR/DFAST and liquidity stress testing requirements, as well as raising the quality, consistency and transparency of various financial and operational risk, as required by the Dodd-Frank Act, is driving banks to collect, analyze and report more detailed data to regulators, auditors, management and customers.

To meet these requirements, banks need to address the challenge of establishing real-time visibility, analysis, and reporting of enterprise-wide data. Many banks need to transform their existing IT infrastructure rather than simply reacting to regulations on a case-by-case basis. Instead, banks are being driven to come up with a well-designed plan to transform their IT infrastructure and operations to meet current (and future) mandates.

To meet these requirements, banks need to address the challenge of establishing real-time visibility, analysis, and reporting of enterprise-wide data. Many banks need to transform their existing IT infrastructure rather than simply reacting to regulations on a case-by-case basis.

Figure 1 Overview of maturity levels in stress testing



Source: Moody's Analytics

Some organizations are aggressively consolidating their systems, seeing the need for regulatory compliance as an opportunity to fix systems that may not be working optimally. An improved IT infrastructure can help banks drive down both the time and cost of maintaining regulatory compliance and, at the same time, enable them to expand resources, expertise, intelligence, and visibility across the enterprise.

What lies ahead for banks with a comprehensive stress testing program?

Initially, banks took a tactical approach to the stress testing requirements. Now many banks have shifted their focus to an effective stress testing process.

One of the pressing questions for many banks involved in the regulatory stress testing exercise is how to best use the investments necessary to create the required stressed measures.

Is the stress testing exercise just a regulatory compliance process or can it increase enterprise value through the creation of effective stress testing tools? The regulatory authorities clearly hope that the stress testing framework and resulting analytics are used to drive business decisions. It is unclear, though, how the information derived from the stress testing exercise will affect those business decisions.

The stressed measures themselves, while helpful with understanding hypothetical capital shortfalls under severe economic conditions, are not necessarily the same measures a bank would use to guide decision-making under routine operating circumstances. Due to the significant costs involved in gathering, validating, and remediating the required data, and integrating various business processes in support of the stress testing exercise, it is important to consider how these investments will pay dividends for normal bank operations not merely as a stressed capital assessment tool.

As a starting point, it is clear that for the stress testing data and models to be useful, they must be leveraged by the underlying businesses that generate or originate risk. This implies that the systems and processes that are built to support the stress testing exercise should be designed in a manner that allows the same infrastructure to support ongoing risk assessment, including risk-based pricing and performance management. Perhaps, this includes many of the DFA 165 enhanced prudential standards.

The systems and processes that are built to support the stress testing exercise should be designed in a manner that allows the same infrastructure to support ongoing risk assessment, including risk-based pricing, and performance management.

The key ways in which banks can generate additional business value include:

- Enhancing forecasting capabilities around credit-adjusted new business volume
- Increasing their ability to assess returns on capital after stress
- Linking infrastructure and models to front office credit decision and pricing tools
- Boosting their ability to assess exposure to idiosyncratic shocks to industries, geographies, and pools of credit exposure

Rough seas or smooth sailing ahead?

Banks may not yet have a clear idea of how to leverage their efforts to satisfy the regulatory stress testing requirements, but perhaps they can take solace by considering the "Moneyball" concept that revolutionized Major League Baseball. Moneyball challenged the tried-and-true wisdom of baseball insiders, and instead offered an analytical and evidence-based approach to assembling a competitive baseball team. There may well be great enterprise value in the tools banks are building for stress testing – they may just need to find a new way to take advantage of the changes in their approach to stress testing.

In any case, the stress testing storm will continue and it will be anything but smooth sailing in the short term for banks in the US. The regulatory stress testing and reporting mandates will continue, and the pressure to implement integrated and automated stress testing solutions will push banks to refresh their IT infrastructure.

MEETING THE CCAR CHALLENGE

By David Place

This article provides an overview of the CCAR challenges that banks face and offers ways to successfully overcome them to comply with the regulations and to enhance business decisions.

David Place
Managing Director, Americas Sales

David helps financial institutions worldwide make more informed investment, credit, and enterprise risk management decisions, and provides insight into software solutions for stress testing.

After years of uncertainty and speculation about the scope of stress testing regulations and requirements, institutions have a much clearer picture of the regulatory landscape. As we prepare for the third year of the annual CCAR process, we are now moving from a tactical stage as it relates to the CCAR exercise to a more strategic stage. However, with regulators envisioning that stress testing will transform the industry and the perception that many institutions are treating stress testing like a burdensome "check-the-box" exercise, there is still a discrepancy between how each views the value of the regulations.

Many have already devoted considerable time and resources to comply with the new regulatory guidelines and are asking whether or not stress testing is worth the continued investment. More precisely, is it likely that the level of scrutiny to this topic will fade in the future? Will everyone sufficiently support their stress testing capabilities to embrace the implementation of a more effective process?

Throughout this publication, we have taken a closer look at the opportunities and challenges of stress testing in the US – 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, my colleague Dr. Christian Thun addressed the question "Are regulatory stress tests just cost without value?" Some may believe this to be the case, especially if the ever-increasing scope and related data requirements of the tests have little to do with an institution's individual risk profile.

Complying with regulations is neither generally welcome nor easy. Yet, in a very short period of time, stress testing has become both a central regulatory necessity and for many a key risk management tool. It represents an opportunity to more fully consider a broad range of 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 as more progressive institutions build the infrastructure necessary to both comply and compete in the future.

Taking the stress tests seriously

Institutions that understand how the new requirements can vastly improve existing processes – such as credit loss estimation, budgeting and planning, asset and liability management, and risk and financial management – are at the forefront of a new era of risk management. At the same time, senior management must also acknowledge that existing systems and processes are ill-suited to handle the current expectations. With CCAR evolving and becoming an integral part of the risk and capital management frameworks at institutions, management needs the capability to respond efficiently to current demands

and the flexibility to be able to address future requirements.

Banks face multiple challenges

- **Data management:** Granular data is essential for stress testing and CCAR bottom-up modeling purposes. Financial institutions will need to centralize 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 results 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 regulators. Firms will need to be able to document and maintain their bottom-up and/or top-down models and be consistent over time and across asset classes. These models, and the underlying data used to construct them, will help them to meet the CCAR regulatory requirements while continuing to ensure that risk taking is consistent with shareholder expectations and their risk appetite.
- **Reporting:** Supervisors will require more frequent stress testing and reporting. Financial institutions are required to publish monthly, quarterly, and annual reports in a 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 flexible enough to keep pace with evolving regulations.
- **Stress testing automation:** Financial institutions will need software to coordinate and centralize the stress testing process to keep consistent scenario and modeling 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.

Figure 1 illustrates how stress testing represents a unique challenge, in terms of integrating data, models, platforms, and reporting across an organization.

THE CCAR PROCESS HIGHLIGHTS INDUSTRY WEAKNESSES

Governance

- Fragmented coordination efforts across finance, treasury, and risk groups
- The need for more timely communication throughout the chain of command, as C-suite and senior management are engaged in scenario definition, results, and review
- Board-level education efforts are difficult to structure and maintain

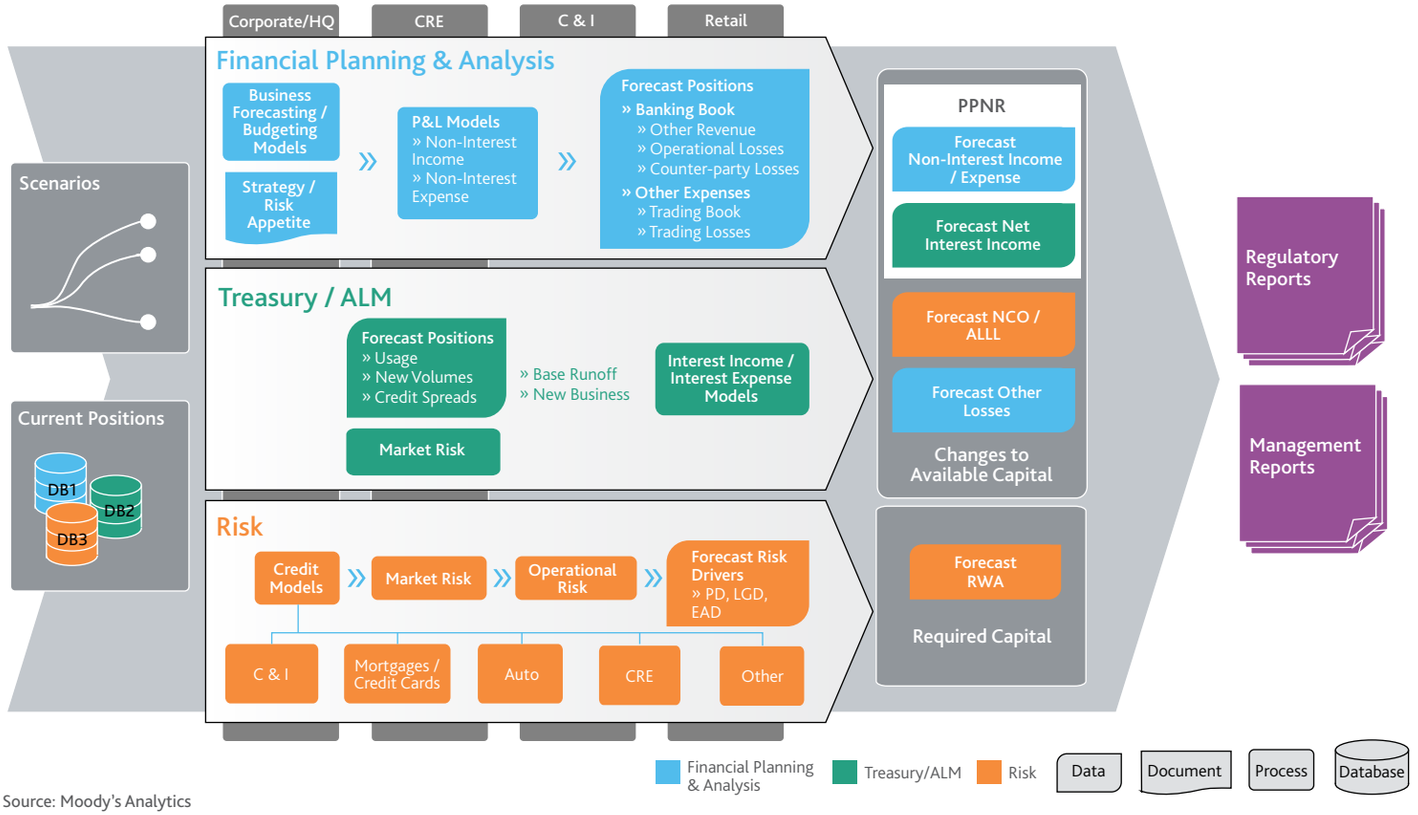
Process

- Lack of integration of stress testing with forecasting processes and resources
- No immediate manpower for increased frequency of stress testing
- Lack of harmonization between Fed stress testing methodology and GAAP accounting
- Deterministic scenarios may not uncover future sources of crisis; there is a need for more institution-specific scenarios and systems that can support their frequent analysis
- Auditability of results is not easily accomplished

Models

- Evolving and disparate methodologies
- Emphasis on greater granularity, consistency of loss estimation, and new business methodologies means many current models are in need of an update or replacement
- How to identify and quantify "unknown unknowns"
- Event-driven scenarios need to use thorough and well-governed analysis rather than routine models

Figure 1 The CCAR Challenge



Source: Moody's Analytics

Technology

- Spreadsheet-based infrastructure is clearly inefficient
- Manual processes constrain:
  - Frequency of stress testing
  - Reconciliation and controls
  - Ability to analyze results
- Competing priorities
  - Need for long-term infrastructure planning and enhancements versus short-term CCAR / DFAST timeline
- Existing infrastructure not well suited for CCAR / DFAST process

Institutions 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. New guidance confirms regulators have ramped up their supervisory focus on stress testing, requiring tests more frequently and with more complexity.

The regulatory stress testing and reporting mandates will continue, and the pressure to implement integrated and automated stress testing solutions will push institutions to refresh their IT infrastructure.

Effectively addressing the stress testing challenges will enable 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 business. In the end, a thoughtful, repeatable, and consistent stress testing framework should lead to a more sound, efficient, and (above all) lower-risk marketplace.

SUBJECT MATTER EXPERTS

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Shirish is experienced in numerical and high-performance computing and computational finance. He has worked on Monte Carlo methods, numerical optimization, and parallel computing. At Moody's Analytics, he works in the Structured Analytics and Valuations group on the Portfolio Analyzer platform for analyzing residential mortgages, auto loans, and asset-backed securities. Shirish has also taught at IIT Bombay and Cornell University.

Shirish has a PhD in Mechanical Engineering from Cornell University and an MA in Mathematical Finance from NYU.

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Stephen leads Moody's Analytics Structured Analytics and Valuations group in EMEA, providing off-the-shelf and customized data, software, valuations and advisory solutions to structured finance market participants, including hedge funds, asset management firms, banks, and regulators.

He helped develop and implement Moody's Analytics integrated stress testing, valuation, and PD/LGD-modeling approach for structured finance, combining macroeconomic forecasts, asset class-specific credit models, and comprehensive transaction-specific cash flow models. He also leads the team that has used this approach for advisory engagements in the US, Europe, and Asia for over five years, with a current focus on regulatory compliance for CCAR, AIFMD, and upcoming stress testing / regulatory initiatives.

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Greg is a member of the Stress Testing Task Force at Moody's Analytics. He helps clients automate their stress testing processes, providing insight about architectures, data management, and software solutions for risk management. Greg has in-depth knowledge of the risk management business, coupled with a strong technology development background, and has extensive experience developing innovative and strategic technology solutions.

Prior to joining Moody's Analytics, Greg had senior roles in Oracle Financial Services and Citigroup, where he ran a large risk technology development group.

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Thomas helps solve complex stress testing, capital planning, and risk management problems – across portfolios and product sets – for financial organizations worldwide. Thomas is a recognized industry expert with more than twenty years of multifaceted experience in financial risk management, corporate governance, business leadership, and development.

His areas of focus include: CCAR/DFAST, PPNR, capital budgeting and planning, performance and balance sheet management, Basel II/III, and economic scenario planning, scenario creation and management.

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Michael has more than 25 years of experience in financial services, spanning bank risk management, risk consulting, investment advisory services, and pension consulting – focusing mainly on risk management and credit risk management.

Before coming to Moody's Analytics, he ran the Risk Analytics Group at SunTrust for six years. His responsibilities included loan loss reserves, commercial model development, economic capital modeling, model validation, and the Capital Stress Testing program. He also spent twelve years at Fleet/Boston Bank. He received his MBA in Finance from The Stern School of Business at New York University and his undergraduate degree from Dartmouth College.

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Cayetano is the Stress Testing, Balance Sheet Management, and Liquidity Practice Leader at Moody's Analytics Enterprise Risk Solutions. He has extensive experience working with financial institutions on credit portfolio management across different asset classes, analysis of structured credit portfolios, derivatives pricing, CVA/counterparty credit risk analytics, stress testing (CCAR, CLAR), and liquidity management. Cayetano holds a BSc and MSc in Telecommunication Engineering, a Masters in Economics and Finance, and a MSc in Financial Mathematics, with distinction, from King's College London.

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Brian is an insurance and Solvency II specialist who has significant experience in technology solutions for the global insurance industry. He has an in depth knowledge of the life and pensions business, coupled with a comprehensive understanding of enterprise technology in relation to the development and implementation of core administration, actuarial/risk, data and Solvency II systems.

Brian has previously worked with many insurance companies across the world and has run administration and sales divisions. He also has considerable experience in strategic planning. Brian is a noted conference speaker on insurance technology, actuarial modeling, and data governance and has previously authored tutorial material for both the CII and PMI.

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Tony oversees the Moody's Analytics credit analysis consulting projects for global lending institutions. An expert applied econometrician, he has helped develop approaches to stress testing and loss forecasting in retail, C&I, and CRE portfolios and recently introduced a methodology for stress testing a bank's deposit book.

Tony was formerly the lead Asia-Pacific economist for Moody's Analytics. Prior to that, he held academic positions at the University of Adelaide, the University of New South Wales, and Vanderbilt University. He received his PhD in Econometrics from Monash University in Melbourne, Australia.

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Andrew is in charge of developing methodologies for structured finance analysis and quality assurance with the Moody's Analytics Valuations team. His previous experience at Moody's spans ratings, project management, pricing, and analytics capacities. Additionally, Andrew was a CLO portfolio manager at HypoVereinsbank.

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Anna is responsible for the business development of stress testing and capital planning solutions. She helps clients from a variety of financial institutions, including those in the insurance, banking, and consumer finance sectors. Prior to her current role, she was with Enterprise Risk Solutions leading engagements with financial institutions across the Americas in loss estimation and counterparty credit risk management. Before joining Moody's, Anna worked at the Financial Institutions Investment Banking group at Bank of America. She holds both a BS in Finance and International Business and a MA from the Stern School of Business at New York University.

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Nicolas Kunghehian

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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 an 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 degree in Mathematics and Economics from the Ecole Polytechnique and a degree in Finance and Statistics from the Ecole Nationale de la Statistique et de l'Administration Economique.

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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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David is responsible for helping financial institutions worldwide with their enterprise risk management, liquidity, and stress testing solutions. Since joining Moody's in 2002, David has been Managing Director in the Product Strategy group, responsible for a global portfolio of research, data, and analytic products across all fixed income asset classes, led end-of-day pricing business at Moody's Evaluations Inc., and headed the Global Structured Finance Sales team at Moody's Analytics.

David holds a BA in Economics and Political Science from Yale University and an MBA, with distinction, from the New York University Stern School of Business.

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Dr. Olga Loiseau-Aslanidi

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Olga is directly involved in modeling, forecasting, and stress testing, including key market risk variables, against different macroeconomic scenarios, and designing macroeconomic models that generate scenarios. Before joining Moody's Analytics, Olga worked for an economic consultancy firm, taught several economics courses, and performed academic research focused on macroeconomics of emerging markets.

Olga holds a PhD and MA in economics from CERGE-EI, a joint workplace of the Center for Economic Research and Graduate Education of Charles University in Prague and the Economics Institute of the Academy of Sciences of the Czech Republic.

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Pierre has more than 10 years of experience helping provide financial institutions with risk management solutions, including asset and liability management, liquidity risk, and capital adequacy.

He has served as a Solutions Specialist of risk management for banks since 2008. Prior to that, Pierre worked for leading advisory firms in France as a project manager. He has a degree in Computer Science from the French Grande Ecole Telecom Paris Tech.

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Victor Pinto

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Victor has more than 15 years of experience in the financial industry and risk management and currently leads the software and risk management solutions team for banking in EMEA. He joined Moody's Analytics in 2004 via Fermat and since then has been promoting risk management solutions for financial institutions around the world, having participated in many important sales opportunities in the company.

Prior to joining Moody's Analytics, Victor worked as a project manager and business analyst in several investment banks.

Victor holds a degree in Information Systems and a MBA from the Sorbonne Graduate Business School (IAE de Paris).

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David joined Moody's Investors Service in March 2001 as a sales representative covering key buy-side accounts in the Midwest United States. He later worked as both a Business Development Officer and a Global Account sales representative before becoming a Sales Manager in 2006. In 2008, David was named Managing Director and Head of Sales for the Americas.

Prior to joining Moody's, David worked for 13 years at The Bank of Tokyo, holding various commercial banking roles including leading the Mid-Atlantic corporate banking team. David holds a BA in Business Administration from Lycoming College.

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Michael leads the Regulatory Compliance and Capital Management solutions team for the Americas. He focuses on assisting banks across the United States with various aspects of the CCAR/DFAST and Basel regulations. Michael joined Moody's Analytics in 2002 and spent a number of years managing the firm's relationships with large global financial institutions.

Prior to joining Moody's Analytics, Michael worked in Investment Banking at Commonwealth Associates, a boutique firm. He holds a BA from Fordham University along with an MBA in Marketing from the Fordham Graduate School of Business.

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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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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 of 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 become an internationally-known expert on credit risk management.

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Michael helps deliver advanced portfolio credit risk, stress testing, correlation, and valuation solutions to global financial institutions and regulatory organizations. He is the practice lead for origination services in the Americas, developing and managing services around stress testing, lending workflows, pricing, and limit setting.

Previously, Michael worked in the portfolio credit risk area of Moody's Analytics, delivering over 40 portfolio analysis projects that covered economic capital, stress testing, portfolio optimization, correlation estimation, retail pooling, and portfolio valuation.

Michael has BS and MS degrees in Engineering from the University of California, Berkeley, and credit-related coursework at the Stanford Graduate School of Business and at the Kellogg School of Management.

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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 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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- Assist with defining both macroeconomic and business-specific scenarios
- Offer a comprehensive and granular credit risk, economic, and financial data set
- Help model the impact that macroeconomic cycles, regulatory directives, and/or outlier events may have on an institution's risk profile
- Deliver an integrated stress testing software solution to calculate stressed performance indicators across the risk and finance functions

For more information contact our stress testing experts at RiskPerspectives@moodys.com.

INFRASTRUCTURE

Scenario Analyzer™

Coordinates the stress testing process across the enterprise, centralizing a wide range of Moody's Analytics, third-party, and proprietary models.

RiskAuthority™

Delivers comprehensive regulatory capital calculation and management for Basel I, II, and III, including the risk-weighted asset (RWA) calculations required for CCAR reporting.

RiskAnalyst™ and RiskOrigins™

Provide the financial statements and internal Probability of Defaults (PDs) required for CCAR purposes.

Regulatory Reporting Module

Create, validate, and deliver monthly, quarterly, and annual CCAR (FR Y-14) and DFAST reporting requirements. Fully integrated with our platform, this module creates and delivers reports in the required formats.

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Empowers firms to accurately calculate and stress test cash flow based liquidity risk metrics; including those for Basel III and for a number of jurisdictional regulatory requirements.

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SCENARIOS

Global and Regional Macroeconomic Scenarios

Delivered by a team of over 80 experienced economists, who offer standardized alternative economic scenarios, supervisory scenarios, and bespoke scenarios customized to your specific needs for 49 countries, as well as US states and metro areas.

DATA

RiskFoundation™

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Global and Regional Macroeconomic Scenarios

Delivered by a team of over 80 experienced economists, who offer standardized alternative economic scenarios, supervisory scenarios, and bespoke scenarios customized to your specific needs for 49 countries, as well as US states and metro areas.

Global Economic, Financial, and Demographic Data

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.

INVESTMENT ANALYSIS / SURVEILLANCE

Moody's CreditView

Research and data to assist banks with investment analysis, creation of internal risk scores and meeting due diligence requirements.

MODELS

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Provides retail credit portfolio insights into the expected and stressed performance of existing and future vintages, enabling loss forecasting and stress testing.

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Is the leading analytical model for assessing default and recovery risk for commercial real estate (CRE) loans. CMM's stress testing capabilities leverage Moody's Analytics Economic and Consumer Credit Analytics, Federal Reserve's CCAR, and custom scenarios.

GCorr®

Moody's Analytics Global Correlation Model (GCorr) is an industry-leading granular correlation model used to calculate each exposure's contribution to portfolio risk and return for improved portfolio performance.

GCorr® Macro

Macro Stress testing with GCorr Macro produces instrument-level stress expected losses across multiple asset classes to help manage credit risk.

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Calculates the Loss Given Default (LGD) for loans, bonds, sovereigns, municipals, and preferred stock using a range of asset classes and a Comprehensive Database of Defaulted Instruments.

Portfolio Analyzer (PA)

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Enables clients to calculate forward-looking PDs for private firms across different regions and industries and measure how borrowers would be affected by stressed scenarios versus a baseline scenario.

RiskFrontier™

Produces a comprehensive measure of risk, expressed as Credit VaR or Economic Capital, which comprises the basis for deep insight into portfolio dynamics for active risk and performance management.

WSA Platform

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SERVICES

Enterprise Risk Solutions Services

Provide stress testing, model validation, and implementation services.

Valuation and Advisory Services

Provide stress testing, model validation, and implementation services for all structured finance assets.

CONNECT WITH US

Are you LinkedIn to our Stress Testing Group?

Great things happen when people from across the globe join forces to share ideas, best practices, and new ways to overcome their critical stress testing and regulatory challenges.

Join our Stress Testing group on LinkedIn. Connect with the *Risk Perspectives*™ magazine authors and your peers, discuss key topics, and keep up with the latest trends and news. With nearly half of the group's membership at senior level or above, it offers an opportunity to learn more about leveraging stress testing practices to support your core risk management objectives.

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

About Moody's Analytics

Moody's Analytics offers award-winning solutions and best practices for measuring and managing risk through expertise and experience in credit analysis, economic research, and financial risk management. By providing leading-edge software, advisory services, data, and research, we deliver comprehensive investment, risk management, and workforce solutions. As the exclusive distributor of all Moody's Investors Service content, we offer investment research, analytics, and tools to help debt capital markets and risk management professionals worldwide respond to an evolving marketplace with confidence.

We help organizations answer critical risk-related questions, combining best-in-class software, analytics, data and services, and models — empowering banks, insurers, asset managers, corporate entities, and governments to make informed decisions for allocating capital and maximizing opportunities. Through training, education, and certifications, we help organizations maximize the capabilities of their professional staff so they can make a positive, measurable impact on their business.

More information is available at moodysanalytics.com.

GLOSSARY OF TERMS

ABS	Asset-Backed Securities
ALCO	Asset-Liability Committee
ALLL	Allowance for Loan and Lease Losses
ALM	Asset and Liability Management
ARM	Adjustable Rate Mortgage
ARIMA	Autoregressive Integrated Moving Average
BCBS	Basel Committee on Banking Supervision
BHC	Bank Holding Company
BIS	Bank for International Settlement
C&I	Commercial and Industrial
CCAR	Comprehensive Capital Analysis and Review
CDS	Credit Default Swap
CFP	Contingency Funding Plan
CFO	Chief Financial Officer
CLAR	Comprehensive Liquidity Assessment Review
CRE	Commercial Real Estate
CRO	Chief Risk Officer
CVA	Credit Value Adjustment
DCAT	Dynamic Capital Adequacy Testing
DFAST	Dodd-Frank Act Stress Test
DTA	Deferred Tax Assets
EAD	Exposure at Default
EBA	European Banking Authority
EDF	Expected Default Frequency
EIOPA	European Insurance and Occupational Pensions Authority
EL	Expected Loss
ERM	Enterprise Risk Management
ETL	Extract, Transform, Load
FRS	Federal Reserve System
FSA	Financial Services Authority
FSB	Financial Stability Board
FTP	Funds Transfer Pricing
FVA	Funding Valuation Adjustment
FVO	For Valuation Only
FX	Foreign Exchange
GAAP	Generally Accepted Accounting Principles
GCO	Gross Charge-Off
GDP	Gross Domestic Product
GSE	Government-Sponsored Enterprise
G-SIB	Global Systematically Important Bank
G-SIFI	Global Systemically Important Financial Institution
HELOC	Home Equity Line of Credit
HPI	House Price Index
HQLA	High Quality Liquid Assets
ICAAP	Internal Capital Adequacy Assessment Process
ICAS	Individual Capital Adequacy Standards
KPI	Key Performance Indicator
LCR	Liquidity Coverage Ratio
LGD	Loss Given Default
LTV	Loan-to-Value
M&A	Mergers and Acquisitions
MCST	Mid-Cycle Stress Test
MIS	Management Information System
MLE	Maximum Likelihood Estimation
MTM	Mark-To-Market
NAIC	National Association of Insurance Commissioners
NCO	Net Charge-Off
NPL	Non-Performing Loan
NSFR	Net Stable Funding Ratio
OCC	Office of the Comptroller of the Currency
OLA	Orderly Liquidation Authority
ORSA	Own Risk Solvency Assessment
OSFI	Office of the Superintendent of Financial Institutions
OTTI	Other Than Temporary Impairment
P&L	Profit and Loss
PCA	Principal Component Analysis
PD	Probability of Default
PPNR	Pre-Provision Net Revenue
PRA	Prudential Regulation Authority
QE	Quantitative Easing
RAP	Regulatory Accounting Principles
RMBS	Residential Mortgage Backed Securities
RWA	Risk-Weighted Asset
SCAP	Supervisory Capital Assessment Program
SCR	Solvency Capital Requirement
SIFI	Systemically Important Financial Institution
SSFA	Simplified Supervisory Formula Approach
SSM	Single Supervisory Mechanism
VaR	Value-at-Risk
XML	Extensible Markup Language


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