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Data, Analytics, and Reporting Requirements: Challenges and Solutions

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Abstract

The 2007–2009 Financial Crisis highlighted the difficulty, and at the same time, the importance of ensuring banks have adequate capital for economic downturns. In the wake of the 2009 SCAP report and throughout the CCAR 2011 and 2013 cycles, the majority of the stress testing effort went into enhancing analytical modeling. The focus has now shifted toward making the process sustainable, repeatable, and resilient. This paper discusses the implications this shift has to data, not only its capture, but its governance and how to make it accessible to multiple constituents. Technology will be an important part of the solution, but it will also require re-thinking basic business processes. Additionally, to gain the full value of this investment, the interaction with the customer will even be impacted. Data governance, quality, and capture will need to be considered at earlier stages of the data "supply chain," even beginning at the point of risk origination. Banks are in the business of taking on risk — any insight that improves their ability to make those decisions will lead to a competitive advantage.

In this paper, we first provide a background on stress-testing, discuss infrastructure challenges and issues related to legacy data and remediation requirements, including the costs and benefits of improved data management and the challenges of managing multiple hierarchies and reporting dimensions required by the Supervisory Authorities. Next, we cover data governance issues, the data requirements of meeting U.S. stress-testing mandates, and the basic elements of a sound data management infrastructure. We discuss some of the workflow challenges that may require firms to rethink existing business processes and provide a practical example, which involves how banks think about and plan new business actions over a forecast horizon. Last, we profile a stylized system integration for a Systemically Important Financial Institution (SIFI), talk about how the new requirements impact customers, and conclude with some thoughts on the road ahead.

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1. Introduction

The 2007–2009 Financial Crisis highlighted the difficulty, and at the same time, the importance of ensuring banks have adequate capital for economic downturns. In the wake of the 2009 SCAP report and throughout the CCAR 2011 and 2013 cycles, the majority of the stress testing effort went into enhancing analytical modeling. The focus has now shifted toward making the process sustainable, repeatable, and resilient. This paper discusses the implications this shift has to data, not only its capture, but its governance and how to make it accessible to multiple constituents. Technology will be an important part of the solution, but it will also require re-thinking basic business processes. Additionally, to gain the full value of this investment, the interaction with the customer will even be impacted. Data governance, quality, and capture will need to be considered at earlier stages of the data "supply chain," even beginning at the point of risk origination. Banks are in the business of taking on risk — any insight that improves their ability to make those decisions will lead to a competitive advantage.

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2. Background – Federal Reserve's CCAR Stress Testing Process

During the crisis, regulators and many banks were flying blind. Bank data and information were not always available in a timely fashion and decisions needed to be made on the fly. Many banks were unable to create risk and financial impact reports that properly described their positions and exposures, and the ability of banks and regulators to identify, measure, and understand potential losses and, consequently, the adequacy of loss-absorbing capital, was absent. One of the most significant reasons for this problem was the often fractured nature of existing information systems, with data living in what might be called "data silos."

Whether due to the distractions of mergers and acquisitions, growth into new products and markets, diverse and disconnected systems and processes, or being lulled into a false sense of comfort by the lack of significant volatility during the preceding 20 years (i.e., the "Great Moderation"), management was unwilling to invest in more comprehensive and integrated risk infrastructure. As a result, neither banks nor regulators were able to quantify risk exposures and communicate the possible consequences of emerging trends.

Even today, as the memory of this recent financial crisis begins to fade, firms run the risk of falling into a sense of complacency, particularly with regard to the investments required to create a more agile and "risk-aware" organization, able to react quickly in the face of systemic or idiosyncratic shocks. The clear desire is that banks able to identify and mitigate risks, as expected or even unexpected forecasted conditions change, will realize a competitive advantage over those firms focused only on the compliance aspects of stress-testing. Such banks can better plan asset-mix decisions, enhance business strategies around products, geographies, and industries, determine the right mix of funding and capital choices, and better determine performance under a variety of potential future conditions, not merely stressed conditions.

The recent crisis also revealed that much of the banking industry was undercapitalized, or possessed lower quality capital, and was unprepared for a protracted systemic stress that strained or eliminated firms' capital and liquidity formation capabilities. Many banks had made large capital distributions to shareholders, repurchased stock to boost perceived return-on-equity, increased leverage, kept unencumbered liquid assets to a bare minimum, and paid large levels of compensation to senior executives without evaluating the quality, composition, and access to capital under adverse conditions. This mix resulted in a protracted period of higher leverage, including "hidden" leverage, by way of off-balance sheet exposures, and a significant under-estimation of the level and degree of asset-volatility and associated liquidity and funding risks. As the crisis seasoned, many banks were no longer able to fulfill their role as credit intermediaries during the stress period, creating a fairly fragile and highly pro-cyclical financial system.

In 2009, the regulatory community sought to ensure that the largest banks in the United States had adequate capital to survive a continuation of the economic downturn through an exercise called the Supervisory Capital Assessment Program (SCAP). This massive exercise was the first time regulators, and many of the banks, attempted to quantify their exposure through a comprehensive, industry-wide stress test. To support the process, the banks submitted data on each of their portfolios. Given the timing of the request, the majority of the data was supplied using ad-hoc extraction reports on spreadsheet templates. In fact, it

was not until the fall of 2011 that the Federal Reserve implemented the quarterly data collection templates and June 2012 before it implemented the monthly template.

In the wake of the SCAP report and throughout the CCAR 2012 and 2013 cycle, the majority of the stress testing effort went into enhancing analytical modeling techniques related to loss estimation under various economic scenarios and to ensuring banks would have enough capital under severe stress to maintain at least a 5% tier-1 common capital ratio across the forecasted planning horizon.

At the current state of maturity, focus has shifted toward other areas of the stress-testing program, including an intense focus on internal governance processes, increased automation, a focus on supporting business processes and infrastructure, model validation and documentation, sensitivity analysis, and other areas of the measurement methods such as significantly improved PPNR modeling, non-interest income and expense modeling, and the quality of forecasted risk-weighted assets.

3. Post-Crisis Infrastructure Challenges

In many organizations, the current state technology architecture remains a significant challenge. It is not uncommon that core loan accounting systems, while feeding a central enterprise data warehouse (EDW), do not possess all of the data, nor analytical and bespoke service resources, required for stress-testing or regulatory reporting. As mentioned elsewhere in this paper, data is spread across numerous legacy systems, and, in some cases, required data may even be held in spreadsheets and other documents, or simply missing.

The first step in attacking the data challenge is to inventory all of the "feeder" systems necessary to populate the required regulatory reports. To perform this task, the regulator reporting, compliance, IT, and risk management groups must define the critical data sources and gaps. Although not all data can be immediately remediated, it is important that the data gaps are prioritized and resolved in a timely fashion. Within the context of the CCAR exercise, this is important not only for the bank but to provide evidence for the supervisory authorities regarding the project plan to enhance overall data governance. The data remediation is most efficiently done via internal resources, often the firm's internal audit and loan review functions, with data resolution templates being passed from these groups back to loan operations for data augmentation and improvement. Key performance indicators (KPIs) are usually required to measure progress and report on progress to senior management, the board, and the supervisory authorities.

4. Legacy Data Challenges and Quality Issues

The implications of capturing, storing, and transmitting this data on current processes and systems are easy to understand. Perhaps what is less obvious: some of the data fields that may have been collected for years have never been subjected to much scrutiny, and the quality and consistency of the data will, therefore, be suspect. This data can be categorized into four different types:

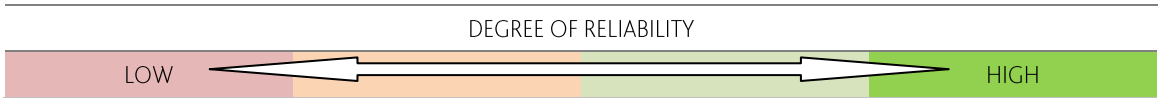
- Data supporting financial statements, such as loan amounts, interest rates, maturities, etc., have long been subject to strong input controls, routine quality assurance monitoring, and regular independent review. This information also has been maintained on legacy accounting systems for many years and was required to be re-validated upon merger or conversions.
- Data supporting origination decisions, such as collateral value, underlying obligor financial data, etc. have also been subject to the same strong controls, monitoring and independent review. However, this information was not necessarily stored electronically. Even if stored on the origination system, it may not have been passed on to legacy accounting systems and was not required to be maintained upon merger or conversions.
- Data supporting the servicing process, such as payment terms or addresses, are subject to less stringent input controls and probably have not been subjected to the same quality assurance or independent reviews. However, through the servicing process, the information will generally receive routine validation with the customer. Also, this information is maintained on the legacy accounting system through mergers and conversions.
- Other indicative data, such as property size, performance of junior liens owned by others, industry code, etc., that may or may not have been collected in the past. Even if collected, these have been subject to very little of the above oversight.

The table below summarizes the relative value of these four different data types by the factors that affect either the quality or the availability of data. Indicative data will have a low level of reliability and will be difficult to rely upon in modeling or capital planning. In contrast, data supporting the financial statements should have a high degree of reliability. Other data, such as

origination or servicing, will have varying degrees of reliability. If the data is used to support a critical model, then the types of controls over financial data should be considered for the other types of data.

Table 1 RELATIVE VALUE OF FOUR DATA TYPES BY FACTORS AFFECTING QUALITY AND AVAILABILITY

	Data Type and their Relative Value			
Factors Affecting Quality and Quantity of Data	Other Indicative Data	Servicing Data	Origination Data	Financial Data
Input Controls	None or very limited existence edits to ensure field is complete only	Limited existence edits, but transparent to customers	Stronger validity edits to ensure data is within allowable range or appropriate based upon other values	Very strong accuracy edits to ensure data is within a specific range and often subject to reconciliation controls
Quality Assurance	Usually none	Little of the data subject to quality assurance monitoring	Most of the data subject to quality assurance monitoring and key fields subject to routine exception reporting to management	All of the data subject to quality assurance monitoring and routine exception reporting to management
Independent Review	Usually none	Usually none	Subject to extensive and regular review by independent parties	Subject to extensive and regular review by independent parties
Historical Availability	Very limited electronic storage and unlikely maintenance through conversions	Stored electronically and high maintenance likelihood through conversions	Some electronic storage, but low maintenance likelihood through conversions	Stored electronically and high maintenance likelihood through conversions



5. Data Collection Cost/Benefit

The reason for the disparity in data treatment? Banks have not valued this information. However, this cost/benefit equation has undergone a significant change due to the CCAR process for several reasons. The first is that, as previously mentioned, the regulators clearly expect banks to continually improve their data quality. This has been evident in their official guidance, in their feedback on monthly and quarterly submissions, and in their supervisory discussions with the banks. In fact, the Federal Reserve, in July of 2012,[1] proposed that each bank's Chief Financial Officer attest to the accuracy of this data. However, in part due to industry feedback, the Federal Reserve recognized that the scope and form of the information collection have not been sufficiently solidified to allow the establishment of infrastructure, general controls, and system validation requirements. While no attestation is currently required, the Federal Reserve has stated publicly that appropriate controls are crucial to ensure data quality, that attestation is an important affirmation of data quality, and that they may revisit the attestation requirement in a future proposal. It is easy to understand the Federal Reserve's position as this data is used to make critical decisions concerning the safety and soundness of the banking system.

Precedent has been established by both the FDIC Improvement Act and the Sarbanes-Oxley Act, both of which required certifications. Implementing those standards was expensive and time consuming. But these certifications both dealt with accounting controls over financial data, which had been subject to audits for a long time and had transparent materiality thresholds to guide management and regulators. Much of the new data is non-financial, and reconciliation controls are much more problematic to implement. Also, some of the data does not have a clear "correct" value. For example, many companies do

[1] See http://www.federalreserve.gov/reportforms/formsreview/FRY14A_FRY14M_FRY14Q_20120718_omb.pdf for more detailed information.

not fit neatly into a particular industry code. An energy company may also own retail gas stations. Should it be categorized depending upon which unit has the most revenue, fixed asset, profits, or volatility?

These types of issues will make implementing controls to support an attestation over the other types of data listed above exponentially more expensive and time consuming. Additionally, as discussed below, the Federal Reserve intends to use this data in the ongoing supervision. To this end, they have been directly and indirectly encouraging the banks to make significant investment into their internal control structures.

As part of the Federal Reserve's continuous supervision programs for monitoring a bank's risks, the Federal Reserve has a stated desire to use the data captured in the CCAR process for ongoing monitoring. In its role as the systemic risk supervisor, and, given this new beginning of standardized data collection, there is meaningful analysis that can be performed within and across the large-bank holding companies. One could think of the data the FRB is collecting as similar to the data found in "trustee" reports filed for Special Purpose Vehicles (SPVs). If you think of a bank as an SPV, the underlying BHCs can be thought of as a sort of "subsidiary" set of SPVs that can be aggregated and analyzed. Equipped with this data and analysis, it is easy to see how the FRB may be able, in time, to spot risk concentrations, observe cross-sector potential for cascading risk transmission across various product markets, and better understand the riskiness of combined "capital at risk" at the system-wide level. Even today, various elements of data submissions are being used by the supervisory community to spot trends across Covered Companies. This procedure is fully consistent with the Dodd-Frank Act's (DFA) requirement under Sections 165 and 166 regarding Enhanced Prudential Standards and Early Remediation Requirements for Covered Companies. It is also not difficult to imagine a day when a model will be used to perform a loan review on the entire portfolio, not just a sample, or to recompute a value at risk amount, not just review calculations. A bank's risk management could be evaluated and scored with limited direct interaction.

But the final reason to re-think the cost/benefit analysis may make that expense seem worthwhile. And that reason is how the Federal Reserve treats missing data. Generally, in the design of a model, incomplete or obviously erroneous data is dropped or adjusted in some way to ensure it does not adversely affect the model's accuracy. However, given that the goal of the CCAR process is to produce estimates of the capital necessary for a bank to weather a severely adverse economic situation and still remain well-capitalized and to continue its intermediation role, the Federal Reserve takes a much more conservative stance. If a bank's submitted data quality is deemed to be too deficient to produce a robust supervisory model estimate for a particular portfolio, the Federal Reserve may assign a high loss rate (e.g., 90th percentile) or a conservative PPNR rate (e.g., 10th percentile) based upon portfolio losses or PPNR estimated for other banks. If the data problem is considered to be isolated in a way that the existing supervisory framework can be still used, a conservative value will be assigned to the specific data. As bad as either of those two results might seem, if the Federal Reserve is sufficiently concerned about the data quality, they can completely deny the bank's capital request, regardless of how much capital the bank is holding. This alone can justify significantly increased expenditures on people, processes, and technology.

All of this data has focused on internal data — data generated by bank personnel during customer interactions. But all banks are obtaining more and more data from external sources. This data varies from historical transaction data, time-series of macro-economic factors, and even projections of future prices or conditions. As this data becomes more imbedded in the bank's processes, the sourcing and use of this information will need to be subject to some of the same controls and validations as internal data. Also, these services can be quite expensive and duplication of information is likely, as this data is often obtained by individual departments, whom might be unaware of what else is available in the organization.

Successful financial institutions will find ways to leverage this data collection exercise to better inform their own internal risk identification, measurement, and reporting processes. This includes adding certain elements to the underlying loan data collection, such as internal hierarchy field names, call report codes, unstructured data capture, images, forms, and other required fields necessary to ultimate ensure reconciliation with the various internal systems and processes that are required to support the analysis, as well as tying back to external regulatory reports. More important may be the addition of additional financial and non-financial data elements that relate to an account, relationship, collateral, and guarantor. The static data alone — those data collected through the FR Y-14M and FR Y-14Q — can provide powerful insights into a firm's exposure(s) and assist in various portfolio stratification reports that have, to this point, remained elusive for many banks. Some firms have begun to consider how the data might be further enriched to support additional business needs of the bank, rather than merely responding to the regulatory mandate.

6. Reporting Structure Misalignment

The above issues relate to the detailed individual loan or event data submissions, but there is another level of complexity added by most of the summary level templates, required to be based upon FR Y9 line items. Regulators had no choice but to use FR Y9 categories in the original SCAP to maintain some level of comparability across organizations. And since that time, they have had to maintain the approach to establish consistency from review to review. Unfortunately, banks are not organized along these categories, but rather by other criteria such as business line, products, or geography. None actually models along these FR Y9 categories, making it necessary to allocate modeled results to line items and impairing the ability to compare the results. A simple example is a commercial loan secured by a primary residence. The bank may have originally underwritten it, continue to service it as a commercial loan, and is likely to model it with other commercial loans. However, since it is secured by a 1-4 family residence, it will be included in residential mortgages on the FR Y9. As an interesting note, the United Kingdom's proposed stress-testing framework does not require a mapping to a pre-specified regulatory hierarchy like the FR Y9. Rather, the Prudential Regulatory Authority (PRA) will work with their covered companies to map a bank's internal business reporting dimensions to the Firm Data Submission Framework (FDSF), which underpins the data collection efforts of the Bank of England (BOE).

For US banks subject to stress-testing, and in order to meet the intent of integrating the capital planning process into daily risk management activities, the bank's systems must support aggregating and reporting stress testing results along lines meaningful to the bank. However, the systems must also allow the same data to be reported along a completely different hierarchy so that the templates mandated by the Federal Reserve can be completed. The best systems will then allow easy translation of the information and results used by the bank to that supplied to the regulators. In addition to having to enhance processes and systems to obtain, validate, and audit all this data, there will also be a much greater need to "persist" the data through time. Increasingly, the regulatory expectation is that this data will be "versioned" so that new models can be run on old data to help understand the impact of changes, as well as old models being run on new data to benchmark and validate improved model performance. This process will allow a firm to show how incremental improvements are made over time, as well as allowing for various back-testing and improved internal model building.

7. Data Governance

The greatly increased need to obtain, store, manipulate, analyze, and integrate data has implications beyond just the obvious needs for better processes, systems, and controls. It will require a fundamental rethinking of how we view data. As customers, and as the world becomes more integrated, and, given the fact that stress-testing is not a US key regulatory initiative but an initiative at the G-20 and Financial Stability Board (FSB) objective, banks are being required, by fiat, to become more integrated in how they make their money— managing risk. In most banks today, there are many different data owners, each in their own silo, very knowledgeable of their data and how they use it, but largely ignorant of how others in the organization can or should use it.

In order to wrap effective controls around a firm's data management processes, it is increasingly common for large organizations, and even some smaller firms, to create a new "C-" level position: the Chief Data Officer (CDO). The CDO is responsible for establishing data standards, policies, controls, and accountability. Usually reporting to the Chief Technology Officer (CTO), the CDO works to prioritize data acquisition, architecture, process controls, and overall enterprise data strategy. But the technology is not the difficult part of the problem. In many banks, data has never been treated as an asset of strategic corporate value. This outlook has been a mistake, as tools to capture, mine, and evaluate data continue to improve their ability to better serve customers, create enhanced decision support tools, monitor trends, detect risks, and form new opinions and insights regarding business opportunities has become much more profound.

Like many large corporate and information technology companies, banks are beginning to apply supply-chain concepts to data flow. They are beginning to understand that data is a treasure trove of information and, when combined with other data sources, can be exploited to enhance shareholder value. In fact, effective data management may emerge as a key competitive differentiator in the years to come, as the banking model itself comes under pressure and as firms with better control over data will also be able to improve efficiency, create better business intelligence, and accelerate decision-making with better information.

The implementation of a data governance framework can differ significantly from firm to firm. However, all data governance programs involve aligning the organization around improving the integrity of data capture, security, availability, storage, and use. Firm's require a centralized focus to determine the information required to meet goals, establish standards for business units to capture the information, source required information from external parties, and make all of the data available for individual groups to exploit on an "as-needed," "just-in-time" basis. For stress-testing, current governance activity is primarily focused on establishing new policies and procedures for the remediation and filling-in of missing and low quality data and ensuring the completeness, audit, control, and accountability for data enhancement across the organization. However, for banks, as the amount of data increases and the accessibility is expanded beyond a specific business unit, security and the "need to know" will become

increasingly more important to manage. This is true not only of the firms involved and the data banks must maintain and improve, but for the regulatory agencies themselves as well. The level of data granularity required by the US supervisory agencies will require a pristine process for access control and user control.

The next section of this paper provides insight into the comprehensiveness of the requirements in the US CCAR process.

8. Stress-Test Reporting and Data Collection Templates

In order to conduct a Federal Reserve styled stress-test, one begins with the FR Y-14 M/Q/A reports. The SCAP process created a recognition that few firms, if any, possessed the quantitative, rigorous process necessary to model a firm's entire balance sheet, income statement, and pro-forma regulatory capital. While SCAP's goals were different from today's process, with SCAP focused more upon establishing public confidence that banks would have the capital they needed — by public markets or by government mandated capital infusions, the CCAR process is meant to institutionalize confidence that large, systemically important banks have the capital buffers needed to withstand stress.

To forecast risk to financial condition, including capital, requires understanding all of the material exposures across the firm, the earnings produced by assets, the costs incurred by liabilities, and how these measures and management actions, change under routine and adverse conditions. This includes unfunded commitments and off-balance sheet exposures that, under stress, may revert to the firm's balance sheet, a significant risk not fully appreciated In truth, the CCAR exercise is a dynamic forecast of all balance sheet exposures with an eye toward credit, market, price, and interest rate risks. While banks have measured interest rate risks through ALM models for quite some time (i.e., since the last major financial crisis), the requirement to integrate credit loss estimates, non-performing assets, credit adjusted new business plans, fair-value measures including other than temporary impairment (OTTI) of investment holdings, dynamic non-interest income and expense, and provisions for loan and lease losses into the business process requires new approaches. To date, the solutions have been a patch-work of various existing risk and finance systems. In the future, banks must integrate across these systems and processes in a more efficient manner. It is important to note that, given the enhanced scrutiny of banks and risk profiles and the critical role banks play in financial markets, as well as the advent of new credit intermediation mechanisms, the bank of the future may look fundamentally different than the bank of today. Executive management and the board of directors must ensure that the strategic direction of their firm aligns with emerging technologies and the realities of changing business models.

To give a sense of the comprehensiveness of regulatory expectations around data, it is useful to review the Federal Reserve's stress-testing data collection requirements. The current data templates required by the Federal Reserve, for all banks over $50 billion in total consolidated assets, subject to certain materiality thresholds, are complex and comprehensive. The current reporting forms and submission templates include the following:[2]

- The annual FR Y-14A: The 14A is the annual "output" report that represents the summary CCAR pro-forma analysis. This report collects forward-looking projections of a bank holding company's balance sheet, income statement, losses, and capital across three different macroeconomic scenarios. This report must tie-back to mandated regulatory dimensions in the bank holding company's FR Y9C filing. In fact, one of the first "audit" points of the supervisors is whether FR Y-14A and FR Y-9C balances are properly reconciled and variances can be explained. The 14A is a "risk and finance" view and must be consistent with US GAAP, reconcile bank to other regulatory reports, follow rules of consolidation, and consider the impact of emerging regulatory deadlines for various elements of the Dodd-Frank Act (DFA) and Basel-III regulatory capital rules. For banks with trading portfolios, a separate report and market shock is required and substantially increases the complexity of scenario analysis and reporting.
- The quarterly FR Y-14Q: Collects a large amount of historical data on Pre-Provision Net Revenue (PPNR), historical regulatory capital and capital actions, summary data on various retail asset classes (including international), investment securities, and granular data on C&I and CRE loans. Much of this data is used to support the Federal Reserve's own model building efforts, as well as to allow for off-site supervision and enhance the System's continuous supervisory monitoring bank examination program(s).
- The monthly FR Y-14M: Collects granular data on loan level exposures, as well as various portfolio level measures, within the mortgage, home equity and credit-card asset classes, including both portfolio and serviced loans.

In 2012, there were four changes to the various reports, and we continue to see ongoing changes and enhancements to the data requests, requiring continual changes to internal data structures, models, and related systems and business processes. Regulatory

[2] It is important to note that much of this data is not merely the submission of exposure information, but data that the Federal Reserve plans to use to build and validate its own internal models. These supervisory models are expected to improve over time, as their data repository across all banks grows, and will serve as a method for the Agencies to challenge internal models as well as support the continuous offsite supervision of the subject banks.

expectations are that these required changes, including data that may not have been collected before (e.g., customer financial statement data), will be implemented in an expeditious manner. While the Federal Reserve has not been overly critical of banks' efforts to date, it is clear that data completeness will become increasingly important. One drawback of this constant change has been that much of the initial response is based upon ad hoc reporting, just as in the original SCAP request. However, as banks continue to work toward a sustainable, reliable, and efficient process, the limitations of the existing data, technology, and workflow become clear. Still, at this stage of process maturity, the ability to fully integrate all of the required elements into one comprehensive solution is not attainable; too many separate business processes exist and the ability to integrate all of the required data, models, business plans, risk measures, accounting views, reconciliation methods, and validation routines will require a firm-wide commitment toward an evolving enterprise architecture that will take years to complete.

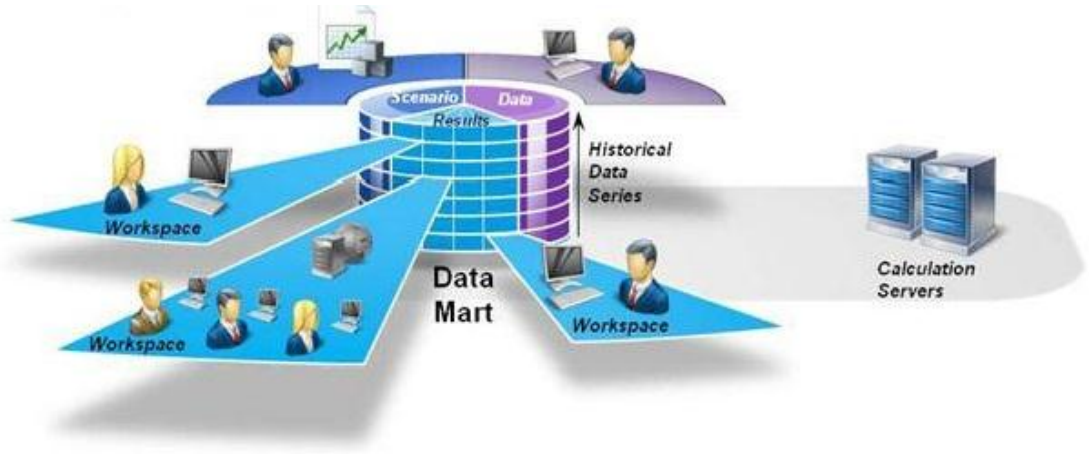
In addition to performing stress tests utilizing the Federal Reserve's scenarios, the individual bank's macroeconomic scenarios, or stress-testing requirements from other jurisdictions, banks are coming under increasing pressure to identify and calculate idiosyncratic risk. Moreover, even various rating agencies are giving increased attention to a firm's ability to conduct stress-tests in a comprehensive and complete fashion. The bank is expected to understand its business model, including securities, loans, deposits, and revenue and expense drivers, to determine what unique events or conditions might impact its capital and, increasingly liquidity position. Banks are encouraged to run as many of these scenarios as possible and to consider what individual or combination of events could occur. Again, the bank is expected to aggregate this impact across the entire entity. Any ad-hoc analysis is expected to demonstrate rigorous controls, including both the reconciliation and governance controls, to which the main scenarios are subject.

The intensity of the data quality management requirements, and the fact that errors in the process can potentially lead to unwanted regulatory remediation is causing many banks to rethink data chains of custody, reconciliation processes, and, perhaps most importantly, making data quality a critical element at the point of deal origination, data entry, and asset and liability "boarding." In many cases, this addition requires inserting new technology within a firm's overall enterprise architecture that forces better data input, error detection, and error correction at the point of deal capture.

9. Database Requirements

The data, rules sets, hierarchies, and related information that underpin stress-test is ideally pulled from a common data-store. In many organizations, this requires the acquisition or build of a specialized data-mart,[3] or augmentation of an existing data warehouse, to support the scenario design, CCAR/DFAST and capital planning process, and requires integration and interfaces across multiple pre-existing systems. This data-mart must possess a model that handles the required data inputs and result files covering finance, treasury, credit, trading, mortgage banking, regulatory capital, and, over time, liquidity (see Figure 1). The data-mart must cover risk, finance, financial products, regulatory rules, and reporting models in a comprehensive fashion.

Figure 1 Data-Mart: contains scenarios, reference data, and computational results stress testing.



[3] A data-mart is a specialized subset of a broader data warehouse. A data-mart is usually oriented to get data out to business users and align to a more specific set of business requirements, such as stress-testing, regulatory reporting, and/or capital and liquidity planning.

Given the data criticality, and the fact that the data and results will inform the bank's capital plan and possible regulatory approval of capital actions such as dividends and compensation, the security, auditability, scalability, maintainability, versioning, and efficiency of the data-mart must be unquestionably strong. Whatever data-mart and associated infrastructure is used must also possess the required structure to handle forecasts (i.e., input and output data sets), multiple regulatory reports (e.g., the FR Y-9C the FFIEC 031/041, the FFIEC 101, and (possibly) the FR Y-16), instantiate required user, administrator, data custody workflows, and be able to persist extremely large volumes of data.

Even for firms that have invested heavily in enterprise data-warehouses, many find that most data warehouses are not "built for purpose" for the regulatory mandated stress-tests. This includes consideration of the numerous rules and edit checks necessary to link and reconcile across internal and regulatory reports, particularly where a bank is operating in numerous different countries or regions, each of which may have different scenarios, data, forecasting horizons, aggregation, reporting, operational, and other idiosyncratic requirements. Most processes then, as they exist today, rely upon spreadsheets and many manual processes that can be quite error prone.

In the development of solutions for the task, banks must consider capturing data at the most atomistic level, as various areas of national discretion (and, such as the United Kingdom or the stress-testing requirements of the European Central Bank (ECB)) may require a variety of different aggregation points and forecast horizons. A firm able to capture position level data can always "aggregate-up" to higher, pool level cohorts. However, if a system is designed in reverse — starting with aggregation pools — the ability to move down toward the position level becomes more difficult and may run afoul of various regulatory requirements by jurisdiction.

For US banks, it is not uncommon to find that numerous pieces of the Federal Reserve's data and risk measurement inputs are "scattered" across various sub-ledgers and specialized risk, finance, loan accounting, servicing, collections, document preparation, origination systems, and even custom spreadsheets and small databases that have never needed to pass various of these data fields to a central data-warehouse.

For example, when looking at the data request for the FR Y-14Q, Corporate Loan Data Schedule (below), eighty-two (82) different data fields are required. A similar level of data requirement exists for investment securities, retail loans, commercial real-estate, and other exposures (e.g., mortgage servicing rights, trading risk positions, and PPNR). Many of these data fields are not simply the contractual information related to the loan, but the request asks for data that crosses the origination system, collections, servicing, loan spreading, and loan accounting (i.e., fair value and ASC 310-30). Table 2 provides an indication as to the expansiveness of the data request for C&I loans; similar requirements exist across all loan categories.

Table 2 FR Y-14Q CORPORATE LOAN DATA SUBMISSION

- Customer ID
- Interal ID
- Original Internal ID
- Obligor Name
- City
- Country
- Zip Code
- Industry Code
- Obligor Internal Risk Rating
- TIN
- Stock Exchange
- Ticker Symbol
- CUSIP
- Internal Credit Facility ID
- Original Internal Credit Facility ID
- Credit Facility Internal Risk Rating
- Origination Date
- Maturity Date
- Credit Facility Type
- Other Credit Facility Type Description
- Credit Facility Purpose
- Other Credit Facility Purpose Description
- Committed Exposure Global
- Utilized Exposure Global
- Line Reported on FRY9C
- Line of Business
- Cumulative Charge-Offs
- FVA
- ASC 310-10
- # of Days Principle and Interest Past Due
- Non-Accrual Date
- Participation Flag
- Lien Position
- Security Type
- Interest Rate Variability
- Interest Rate
- Interest Rate Index
- Interest Rate Spread
- Interest Rate Ceiling
- Interest Rate Floor
- Interest Income Tax Status
- Guarantor Flag
- Origination System
- Guarantor Internal ID
- Guarantor Name
- Guarantor TIN
- Guarantor Internal Risk Rating
- Entity Internal ID
- Entity Name
- Entity Interenal Risk Rating
- Date of Financials
- Data of Last Audit
- Net Sales Current
- Net Sales Prior Year
- EBITDA
- Adjusted EBITDA
- Interest Expense
- Net Income Current
- Net Income Prior Year
- Cash and Marketable Securities
- Accounts Receivable Current
- Accounts Receivable Prior Year
- Inventory Current
- Inventory Prior Year
- Current Assets Current
- Current Assets Prior Year
- Tangible Assets
- Fixed Assets
- Total Assets Current
- Total Assets Prior Year
- Accounts Payable Current
- Accounts Payable Prior Year
- Short Term Debt
- CMLTD
- Current Liabilities Current
- Current Liabilities Prior Year
- LTD
- Minority Interest
- Total Liabilities
- Retained Earnings
- Capital Expenditures

While these data can be placed in a central data-warehouse, the need to link and reconcile numerous regulatory reporting hierarchies, accommodate forecast input, absorb elements of the FP&A and ALM output, and store scenarios, scenario consistent

market data,[4] business origination strategies, general ledger files, and a range of assumptions across multiple business lines and geographies, while also allowing for automation of numerous workflows and "workflows of workflows," requires considerable thought around architecture and design. In practice, this project requires a fairly agile data layer. In some cases, necessary data, data layout, or calculation output from one system, perhaps supplied by one vendor, may be contractually precluded from being used in another risk, finance, or other third-party solution that is necessary for producing the stress-testing result(s). In some cases, this may be a potentially profound legal problem that has not yet been recognized or properly addressed by the supervisory authorities.

As banks begin to look at increasing their investment in improved infrastructure, these data stores and processes should not be created solely to support the stress-testing exercise. There is an expectation that the underlying internal design structure is coherent, and that the internal plans are such that the data and processes are used to support multiple business purposes, including meeting what the supervisors consider the "use-test" (i.e., that the overall results, systems, and processes are "used" in regular bank management and decision-making). This requires integration across existing and planned systems, and most firms are still in the design phase of this architecture. Firms are expected to possess a data infrastructure that allows them to support the stress-testing on an on-going basis, creating an automation and integration framework that allows for more frequent, timely, and less error-prone submissions.

Based upon most projects to date, it is likely that boards and senior management teams will need to elevate the exposure and funding for the necessary data and technology initiatives. Today, much work remains oriented on compliance rather than meeting business requirements and needs. Clearly, the objective of the regulatory authorities is not merely to create a new cost center. The expectation is that data and the risk and forecasting processes they support will enhance business intelligence and, as a result, produce a safer and less fragile financial system. This will require significant work to explain the strategic utility of the new infrastructure pieces, showing how required infrastructure elements will help improve overall business strategy, firm safety and soundness, organizational profitability, asset allocation choices, and the ability to withstand stress. Banks will also need to consider how to supplement their internal data with other sources.

In many cases, data is simply missing or unavailable due to organizational changes, system sunsets, mergers and acquisitions, and other matters. The expectation of the regulatory authorities is that the internal systems will be enhanced over time, and that concrete strategies are in place to ensure that the bank is able to supply the required data to improve their estimates of losses and revenues.

The following sections cover some of the attributes and capabilities of the data foundation that banks will need to consider deploying.

10. Data Persistence and Versioning

Whatever data-mart is used or built, the data-mart must permit the storage of all historical data: market data, scenario data (across jurisdictions and as needed for models for front-line business use[5]), instrument data, assumptions, model information and versions, input product, portfolio, and accounting files, and related elements that support the creation of the required FR Y-14A report. The data-mart should be designed to archive "snapshots" that contain all of the static data, transactions (including credit risk mitigants), and calculated data as of each specific reporting date. These snapshots must be accessible at any time, with all available features, including processing (or re-processing) and reporting. This feature facilitates data validation, data quality audits, and regulatory review by allowing the user to go back to any given date and report and reproduce results run at that particular historical date or run new versions of models on old data. This flexibility requires contemplation of model versioning within the database such that the "control layer" (a separate element of a well-conceived data-mart) can access prior model versions used across the historical period(s).

[4] In numerous cases, various models require "market data" that may not be provided by the macroeconomic scenario. While the US provides various market data for trading book exposure in their global market shock scenarios, these market shocks are not appropriate for accrual book exposures. Thus, it is important for banks to "fill-in" missing yet consistent market data to ensure internal forecasts are consistent with scenario design.

[5] Not all of the variables provided by the supervisory authority are relevant. For some models, significant gaps exist in the required data. For example, national unemployment, while highly correlated with unemployment in other regions, may not possess as high an explanatory power as unemployment by state, region, municipality, or other more "localized" measure. In other cases, there may simply be more meaningful variables to explain default behavior, business origination options, and other required factors.

11. User Workspaces

A workspace is an environment within the data-mart that has its own partition for the particular user, business process, business unit, or functional activity. This area is the storage compartment for all required input and results files, as well as allowing for any required customizations, such as aggregations, supporting documentation, or unstructured data. The detailed results of various processes that must cater to user needs — such as ALM, liquidity management, risk appetite limits/thresholds, capital plan tables (that may need to be populated), and budget and planning information — can therefore be stored and managed as needed, with integration links built on top of the resulting data model design. The workspace concept also allows groups of users to configure and calculate risk and finance reports in many different ways. This might include running a credit risk loss estimation process using a bottom-up model in one instance and executing a stored aggregation procedure to roll-up accounts and then using a portfolio "challenger" model. Such capability, when integrated via a control layer and linked to the reporting engine, can permit sensitivity analysis around capital calculations that might result from model selection. While not necessarily material on a portfolio-by-portfolio basis, when champion and challenger models are used comprehensively, this sort of capability can assist in model risk management and in confirming the range of possible calculation and model risk error to internal audit, model validation staff, and the bank's primary regulator.

12. Data Integration

Data import should be done in an asynchronous fashion from multiple data stores using an import platform or other extract, transfer, and load (ETL) tool. The data-mart should be able to create, schedule, error-detect, and report around pre-built and required customized integration interfaces. The data system must be able to collect data from multiple sources and target a consistent format for the end-user. This allows for one central location to load, enhance, and review data quality as it pertains to stress-testing and reporting.

13. Data Model Coverage

The data-mart should have a data model that reflects the realities of both static data and related reporting, as well as forecast data and associated reporting. Dedicated tables and screens should be available to manage each type of data structure such as market data, static data, transactions, parameters, and any calculated data. Owners of data objects should be specified, easily managed, and allow for error-filling by the business owners. The data-mart must be consistent, and quickly expanded, around the required transaction level reporting from the FR Y-14M and -14Q, and the data model(s) must accommodate and map to multiple charts-of-account, each of which may possess different aggregation rules (i.e., budgeting and planning, ALM, FR Y-9C, FFIEC 101, and other reporting). This will require firms to rethink current data sourcing and reconciliation routines for in-place legacy systems. Many firms have yet to cross this path due to costs, the "steady-state" of existing functional processes (i.e., if it is not broken, why fix it?), resource and budget constraints.

14. Data Quality, Error Detection, and Checking

Dedicated services and dashboards should be available in order for administrators and users to catalog, visualize, and report on errors and make corrections to the data. As noted, there must be logging of all changes made to data with the change archived for audit purposes. Messages to business owners and data quality managers should be part of the platform and such communication should be stored and available. The system should identify potential problem areas automatically, and it should make use of prior data that has been stored to determine possible "hot spots" with data problems. The solution should allow for "first-assurance" testing so that nothing is missing relative to the firm's general ledger.

Where data is missing, the data-mart should identify missing or potentially erroneous data. Some of this data may never be obtained; banks are unlikely to find it worthwhile to contact a customer with a 15-year old loan to ask about origination data not captured. But, subject to user rules for the target data, systems should be smart enough to fill-in (or "patch") the missing data and generate reports that summarize the data filling assumptions. The data-filling is usually done with a defined "rule set" that users must create . At times, these assumptions can be difficult to benchmark. However, the data-mart should include the ability to chart data errors and data filling over time so that management can track improvement and begin to minimize the need for data fills and associated data assumptions.

15. Reconciliation

One of the most important pieces of the data challenge for CCAR, or any stress-testing regime, is reconciliation. Balances used throughout the process must be reconciled to multiple sources including the GL, the holding company regulatory report filing (i.e., the FR Y-9C), as well as roll-ups from the firm's business plan (i.e., financial planning and analysis), and ALM hierarchies. The data platform should be capable of absorbing the required input files and allow the user to establish mapping rules to validate consistency across the multiple aggregation and roll-up points. This requires that the data model itself be populated with the required data tags that indicate the ultimate target accounts for the underlying data. This is difficult for pre-aggregated data within subsidiary systems. These balances must be identified during the implementation and documented. Problems can also occur when subsidiary systems, such as the GL or other input sources, change dimension structure, add or delete accounts, or when balancing accounts are used, such as suspense accounts, to account for temporary differences. Such complexity requires the ability to message and communicate around data challenges and questions from the data-layer itself.

16. Document Management and Messaging

Given the CCAR exercise requirements, it is important that various documents be stored and versioned alongside the various data submission(s). The Federal Reserve requires detailed descriptions of models, assumptions, and data. This requirement is not simply a documentation exercise, it is an important component of ensuring and demonstrating that the appropriate governance is being applied to stress testing and capital planning. Publicly, the quantitative end results — how much capital each bank has after the nine quarter period, delta between beginning and ending capital, and how close the bank's estimates were to the Fed's estimates — get most of the attention. While there is no argument that those ending numbers are equally important internally, the assumptions and estimates behind the numbers are also critical. Why the macro-environment scenarios selected are the most appropriate for the bank, how these scenarios were used to estimate revenues, expenses, and losses, and, most importantly, the limitations of each of the estimation techniques, must be understood by those that are making the final capital planning decisions.

Moreover, given the difficulty of reconciling across multiple underlying source systems, the need to "message" the various users and administrators of the overall CCAR data model will require ongoing communication within and across the various workspaces that make up the data-mart and data assembly workflows. Owners of the various workspaces must be provided playbooks that indicate how to manage account and hierarchy changes, and the data-mart must be allow for the identification and management of "orphan" inputs as well as data loading errors. Each contributor to the data model must be required to follow a well-defined business process for adding and deleting accounts, or making changes to aggregation rules that might impact reconciliation processes. The data-mart should allow for the loading of the firm's proprietary data dictionaries[6] to assist in mapping, reconciliation, and control.

17. Task Automation and Scheduling

In most banks, books and records are given a "hard close" after one-to-three days post month's end. While not all data from the FRB is required on a monthly basis, it is sound practice to aim for the creation of internal processes that permit monthly data collection of all required data for the annual and quarterly submissions. While not feasible in most banks at this stage of system maturity, monthly time series across the various input elements will set an internal Key Performance Indicator (KPI) quality standard that can help motivate and encourage greater discipline around the required process constituents, as well as assist in enhanced operational processes, model development, and model validation.

In order to assist in this automation, many data pulls, error detection, data filling, aggregation routines, automatic reporting, and error messaging needs to be scheduled via a task automation tool. Given the number of dependencies throughout the process, the sequencing of running the automated tasks is critical, and users that are unable to meet required timelines must develop procedures to handle delays, which may mean creating rules that use prior period values for a current period if the delay creates a critical bottleneck in the overall stress-testing assembly process.

While the above are a few of the data-mart's required elements appropriate for CCAR and capital planning processes, the list is by no means complete. One of the most difficult parts of creating an automation platform for a bottom-up, enterprise-wide stress-testing program as the Federal Reserve has specified is the orchestration of data workflows and associated business processes. It should be clear that the data-mart must have a solid administrative (i.e., data governance and oversight) component as well as a data management workflow component. The system must allow on-the-fly workflows design within established workspaces, as well as on-demand aggregations, but, critically important, must permit the merging of workflows "across" various workspaces.

[6] A firm's data dictionary will reveal how the firm defines products, geographies, legal entities, ratings, and other pertinent information.

So far, we have only discussed the overall minimum expectations , data requirements, and the potential need for customized data-marts supporting the enterprise stress-testing process. We also need a control layer that can access the underlying data, initialize and properly parameterize the underlying models that use the data to develop loss, net interest income, non-interest income, non-interest expense, and regulatory capital measures. Such an orchestration tool is not the primary function of the data-mart. This tool must be able to pass scenario input, scenario-consistent market data, required model inputs, and receive output files from the firm's numerous credit models, PPNR tools, the firm's finance systems, the ALM system, and place computed results into the proper result tables. Few banks have developed or invested in this control layer. However, the technology is established and available, even if not comprehensively implemented at this point in the evolution of stress-testing and capital planning.

18. System Architecture

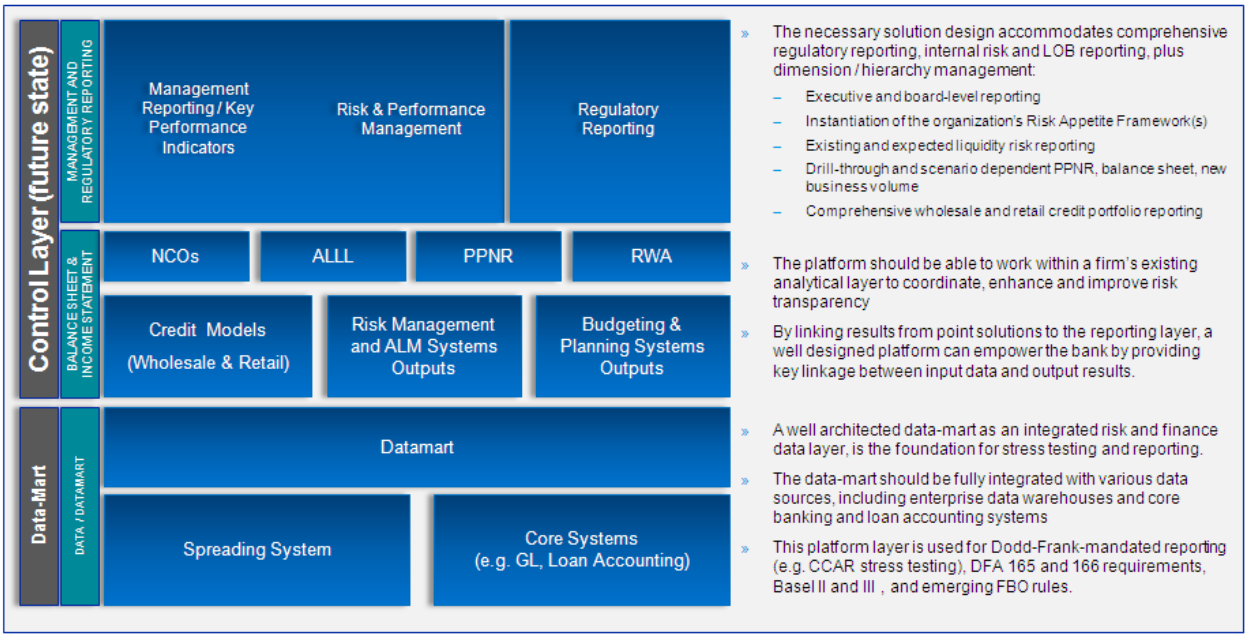
While stress-testing has now been in place for a considerable period of time, banks are just now beginning to think through system design and infrastructure that will allow them to enhance the automation of stress-testing and capital planning processes. As previously noted, one of the biggest challenges of the stress-testing exercise is coordinating the various activities and requirements across the relevant stakeholders within a banking organization, as well as ensuring internal and external reporting consistency across numerous management and regulatory reporting dimensions.

To design a technology environment that begins to streamline this data collection, it is helpful to link certain front-office, origination, and supporting systems into a platform that can allow for a more rigorous "straight-through" processing. Such an undertaking may not be entirely unintended by the regulatory authorities. Many banks have grown through mergers and acquisitions and have not managed to keep their internal technology systems linked together in a manner sufficient to forecast pro-forma financial outcomes. This environment created legal entity and business model structures that result in a level of complexity that, in periods of stress, creates information bottlenecks and information dilution that increases idiosyncratic and, when combined with other large banks, possible systemic fragilities.

19. Platform Overview

Figure 2 provides a stylized example of a possible technology platform that supports a modular, flexible, and comprehensive approach toward the exercise.

Figure 2 Example technology platform.



In Figure 2, we see a single data-mart at the foundation of the architecture stack. As discussed above, this data model should contain all of the underlying scenario and market data, FR Y-14, FR Y-9C, FFIEC 101, risk, finance, and treasury dedicated data structures necessary to begin the analytic and reporting process. This data-mart can be linked to the front-office risk origination systems to assist in populating various elements of the FR Y-14 data requests, as well as the numerous loan origination, servicing, loan accounting, and collection systems (e.g., including specialized areas such as mortgage-servicing rights and the numerous regulatory specified stress-tests associated with those assets). This data-mart can act as the single source for all of the required data for the FR Y-14Q/M reports and serves as the data source for all requisite scenarios and market data. This data foundation may also be the central hub for all of the required data to initialize the bank's various models and can be used to provide the required data feeds for the firm's ALM and budgeting and planning processes. Such a data-store would generally require existing functional processes to re-engineer their current data feeds and reconciliation processes. However, the efficiency gained by pulling from a common, dedicated source readily reconciled to internal and regulatory reports may be a worthwhile consideration for many firms. While potentially disruptive in the short-term, this is an important consideration of system and data design as, ultimately, the goal is to service the needs of the business users, not simply to create a process that satisfies the regulator. Clearly, both needs are important. However, system design should be one that supports capital planning in a robust, on-going fashion, as well as acts as a solution for harmonizing and integrating across multiple risk types. Ultimately, this data store must be ready to support emerging liquidity risk requirements, which, in the United States, are on the docket for implementation in the near term.

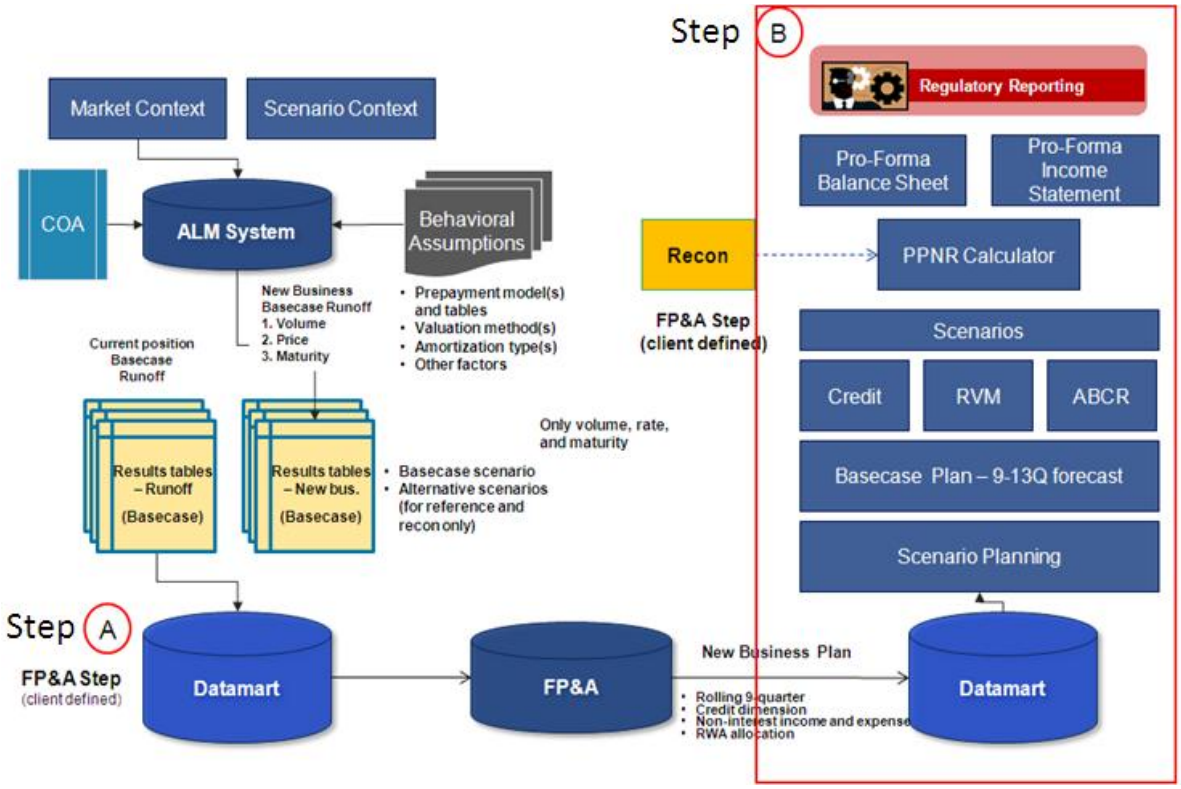
In the above platform design, the business process control layer is not a form of "middle-ware" that all firms have yet contemplated. However, best-practice is for firms to have a central control layer that can act as a sort of "conductor" to link various input data, assumptions, mapping rules, reconcilement routines, business processes, and results from one central hub. This control layer allows for the integration of the firm's various credit loss and PPNR models, can provided consistent input data, as needed, to the bank's ALM system, can accommodate multiple approaches for handling conditional new business volumes with a granular forecast of Basel-standardized and advance approach risk-weighted assets,[7] and non-interest income and expense items sourced from the firm's Financial Planning and Analysis (FP&A) function (or can call additional models that might be used), and will orchestrate the workflow for the analytical inputs into both the regulatory and management reports.

20. Stylized Technical Integration

To give a practical example of the complexity of a technical integration across the various groups might work, Figure 3 provides a reasonable perspective on what a cross-functional integration might look like. For many Globally Significantly Important Banks (G-SIBs), this level of integration is not attainable at the consolidated level, as many of the underlying processes have been "farmed out" to geographic business units, forcing firms to rely upon templates and spreadsheets of acquired/mandated data from each subsidiary business.

[7] In the United States, due to the Collins Amendment to the DFA, many large banks will need to compute capital requirements under both the Standardized and Advanced approaches and use the more conservative of the two measures in their capital planning.

Figure 3 Example of cross-functional integration.



For less complex organizations, the target output, Figure 3 top right, is the regulatory report. For the Federal Reserve, this is the FR Y-14A report, a forecast of the firm's balance sheet, income statement, and capital over a nine-quarter period. This forecast must be conditioned on specified macroeconomic conditions and must comprehensively include conditional loss estimates (feed the provision methodology), net interest income, non-interest income and expense, provisions for loan and lease losses and the allowance, and net income.

To create the proper workflows and data, the process might begin by "seeding" the organization's cash flow tool with the necessary inputs. Due to limitations of many existing platforms, many organizations may insert various components or more modern cash flow tools into the process to assist in creating the required reporting. This may include scenario-consistent credit transition matrices to ensure prepayments, non-accrual levels, and loss estimates are properly aligned to the pro-forma balance sheet scenario and, in some instances, to compute ALLL levels; appropriate and agreed conditional new business volumes; indicative credit spreads for each scenario that have been quantitatively determined, as well as the relevant market data consistent with the economic scenario. The cash flow engine proceeds to calculate a "base-case" scenario, which then is adjusted to fill the chart-of-accounts used by the firm's planning team (see Step A in Figure 3), which requires various application of allocation rules that might be different for the different scenarios. The financial planning and analysis team creates a new business plan on top of the base-case cash-flows and must also estimate base-case, non-performing loans and assets, which may then be passed back to the ALM system to create a "confirmed" base-case scenario. At this point, however, the base-case scenario does not often include the proper credit or regulatory capital dimensions and is void of any measures of non-interest income, expense, or provisions that are consistent with the adverse economic scenarios.

Since most existing processes within banks do not accommodate the integration of credit, non-interest income, and expense, firms instead seek to adjust the base-case estimate in a "closed system" environment that allows the organization to have full control over the assumptions and changes necessary to augment the pro-forma balance sheet, income statement, and regulatory capital measures (see the vertical column in Figure 3). As mentioned earlier, most firms have relied upon Excel worksheets and other manual processes, which are not sustainable platforms. Given the requirement for validation and transparency of the process, the entirety of the business process needs to be captured in a single environment. In Figure 3, this is the vertical column (Step-B) on the right.

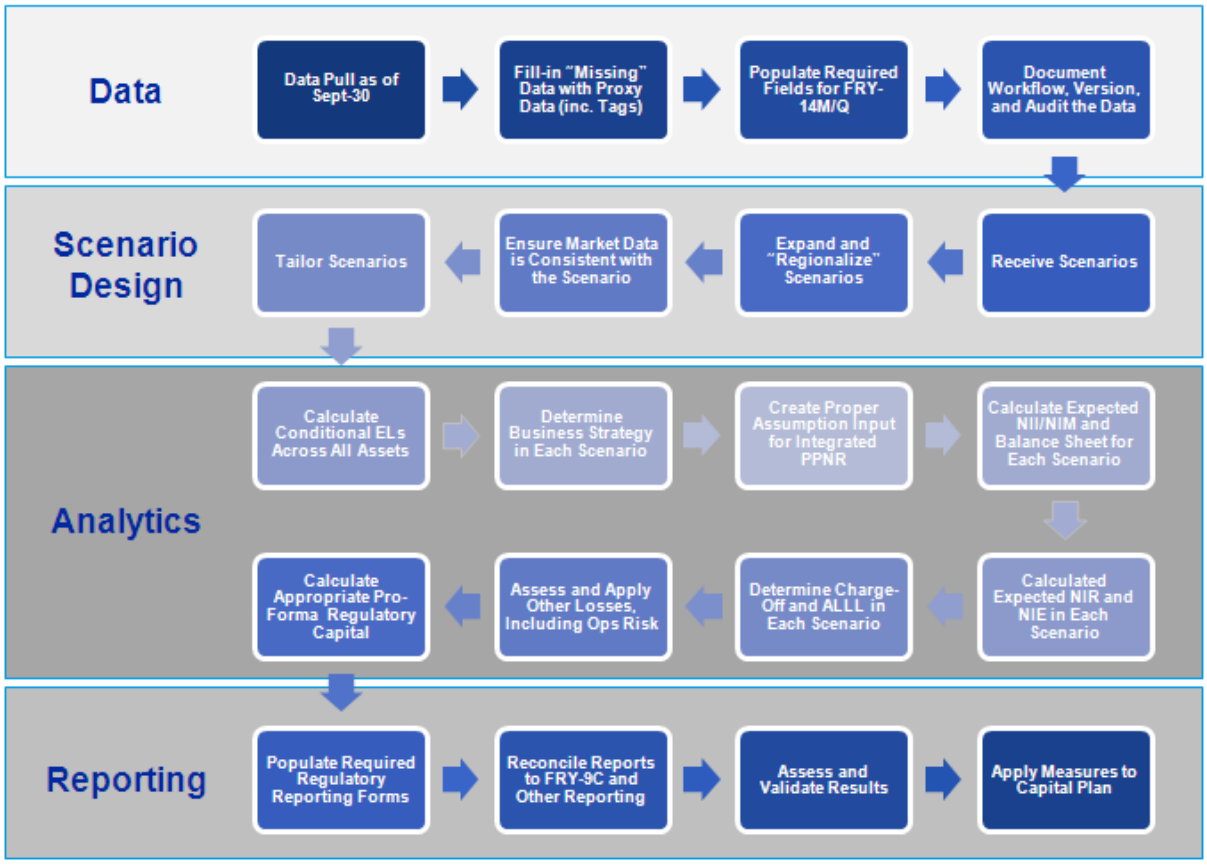
Once the base-case estimate is created, certain adjustments for credit conditioned new business volumes, spreads, and Basel risk weight category, non-interest income and expense, and provisions for loan and lease losses are made and linked to internal business processes. This includes the loss and recovery emergence processes, critical for quarterly allowance for loan and lease loss calculations. Because all of these adjustments are made in a "closed system" and managed by the above referenced control layer, the traceability of the various assumptions and management overrides are easy to find and validate.

21. Business Process Workflow

As should be clear from the above discussion, orchestrating the stress-testing process workflow is difficult at the data layer level, as well as at the analytical modeling and report assembly level. We need to coordinate hand-offs between numerous groups within the organization in a highly structured fashion, and timing is critical. This requires using scheduling software, workflow tools, and management dashboards that allow the entirety of the business process to be "mapped" and managed as timelines and key dates are approaching. Workflows must be created not just for the data layer, but also for coordinating the hand-offs across the various lines of business and risk groups. The business process management (BPM) portion of the exercise is easy to minimize, but may be the most difficult part of the entire process.

To better understand the complexity of the stress-testing challenge, it is important to understand the linkages between disparate functions within an organization. Figure 4 shows a high-level workflow of the entire process, managed by both the workflow engine in the data-mart and the control layer.

Figure 4 High-level workflow diagram.



In Figure 4, everything begins with data. For the Federal Reserve exercise, the data pull for the following year submission begins with the September 30 month end data and March 31 for the July 5th submission of the firm's mid-cycle stress-tests. All of the data required to populate the FR Y-14M/Q must be ready and prepared as close to period-end as possible. The regulatory requirement dictates that this data submission coincides with the same timing as the quarterly FR Y-9C (i.e., holding company

reporting). However, it is best practice to assume that this data is required contemporaneous with the firm's "hard close" of the monthly books and records. While ambitious, this is the goal set by many of the leading banks.

While much can be said about the above workflow, it is important here to note that within each element of this workflow (e.g., imagine "clicking" on a box in the workflow) are different environments and workflows of workflows that must be designed and managed. While Table 3 might naturally create the suspicion that the workflow is sequential, this is indeed not the requirement nor practical reality. The workflow for various elements, once the data is seeded, can proceed. This is especially true if the control layer is in place and already pre-seeded with required input assumption and scenario data needed for various downstream business processes to use. The ability to manage this workflow is critically important. In some organizations the business process engine may color code various elements of the process so that a "percentage of completion" is easily visualized. Each element of the workflow has a dedicated delivery schedule so that emerging bottlenecks are known well in advance and additional resources or management horsepower can be brought to bear on trouble spots.

Last, each of the above steps may involve multiple functional groups within the organization. Such dependencies and collaboration points should be well-defined and integrated into the process mapping exercise. For example, the interaction between finance, credit risk, treasury, and IT is a frequent intersection where multiple groups are dependent upon one another to create the proper forecast. Establishing workspaces that allow for data assembly, modeling, and report assembly is an important design consideration.

As an example, one of the most difficult business process challenges for the stress-testing exercise is how a firm plans forward-looking management actions under the various stress-test scenarios — the base-case scenario and also \the adverse and more-adverse scenarios. With current business habits, the planning function does not plan credit risk, and the treasury (i.e., ALM function) does not care to plan credit or risk-weighted assets (RWA). However, new business volumes must be properly adjusted for the economic environment and the scenario specified by either the bank (idiosyncratic scenario) or the regulatory authority, and credit and RWA are critical elements of the capital planning process. These volumes must consider the credit quality — originated, purchased, or sold — of new volumes, subject to the scenario, and they must cover, at least, the full nine-quarter forecast horizon.

The management plan should be anchored by the existing riskiness of the current position (CP), and management should be able to easily plan how they adjust CP credit quality in the various macro-economic scenarios. The estimated new business volumes should be precise enough to allow for meaningful allocation to the Basel RWA categories on a pro-forma basis, as required by the Federal Reserve. The volume estimates should be informed, not just by qualitative opinion, but by a quantitative estimate of the available demand in the given economic scenario (see modeling discussion below), and they should be compared to the firm's risk appetite in the same scenario. The quantitatively estimated volume should be a function of existing market share versus the credit demand in the various scenarios. The model should also seek to estimate an appropriate credit spread relative to a specified reference curve for each credit quality rating bucket. Instantiating such a workflow is difficult and requires a solid control layer and business process management engine to ensure timely and meaningful results.

22. Re-tooling Customer Interactions

One key point must be re-emphasized here. Most of the discussion has focused on how to make the stress testing process more resilient and efficient — what is most pressing to both the industry and the regulators. But looking longer-term, customer interactions will need to be re-imagined. Some out of necessity: the need to capture more and different data than has historically been captured. Some out of opportunity: the more we know about the customers, the better we should be able to interact with them. This should ease the burden on the customer and speed the transaction, which is critical because, as anyone who has designed these interfaces knows, customers do not like to supply information, particularly if they believe the bank should already possess it.

The centralized collection and storage of this information in standardized formats will aid this redesign. But to achieve this goal, the ability of business units closest to their customers to make autonomous decisions will need to be limited. It is important that banks strike the right balance of centralized control and business unit independence to continue to meet and exceed customer's expectations. However, it is inevitable that this additional overhead will negatively impact a bank's speed to market. Ultimately, the hope is that the improved execution of the strategy will more than offset any lack of nimbleness.

23. Conclusion

Stress testing is here to stay and will become increasingly important to all financial institutions. The techniques and approaches being developed by the Federal Reserve will eventually affect the supervision of all banks. Initially, the focus was on supporting stress testing with quantitative tools, based upon available data. Now the focus must shift to making the process sustainable, repeatable, and resilient. Banks must also seek out new data sources, learn how to capture and control it, and how to make it available to the appropriate business units. Achieving this goal will require not only a substantial investment in technology but also a dedicated effort to adapt new business processes. The technology cannot just automate existing practices, which are not necessarily integrated.

While this paper focuses on the data and technology implications of meeting the regulatory challenges, it also suggest that the most successful banks will those whom learn how to "weaponize" the insight gained from this work into better tools for their line staff. Data and technology exist to meet business purposes, and the business purpose of a bank is to take and appropriately manage risk. The recent financial crisis exposed many flaws in today's enterprise-risk management capabilities, particularly with regard to risk identification and measurement. A key goal of the stress-testing requirements being promulgated by various supervisory authorities presents a challenge and an opportunity. The challenge is creating new processes and capabilities that create a more integrated and comprehensive view of risk. This must begin with data. If anything was learned from the recent financial crisis, it is that the impact of rapidly changing circumstances, and the interaction effects across different risk types (e.g., credit, liquidity, and capital), requires a much more agile and resilient data infrastructure at many firms. You cannot measure what you cannot manage, and one of the key goals of the stress-testing requirements is to focus banks on creating more adept processes to assemble, aggregate, and act upon high-quality data and the risk and financial forecasts that can be built upon such data.

Gleaning insight from improved financial and risk forecasting capabilities and translating it into actionable steps for line bankers will be difficult and requires significant investments in new systems for data acquisition and management. New methods and techniques for business process management are being created to support heightened standards, and firms continue to work toward a future state technology architecture that remains blurry. It will involve all business units and will take a concerted effort, over a number of years, to implement. Banks will need to consider broader organizational implications, including re-alignments, new business process workflows, new key performance measures, and new units, to achieve the full benefit of the required expenditure. Senior management and boards should be prepared to support this change with an appropriate structure and capital investment.

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