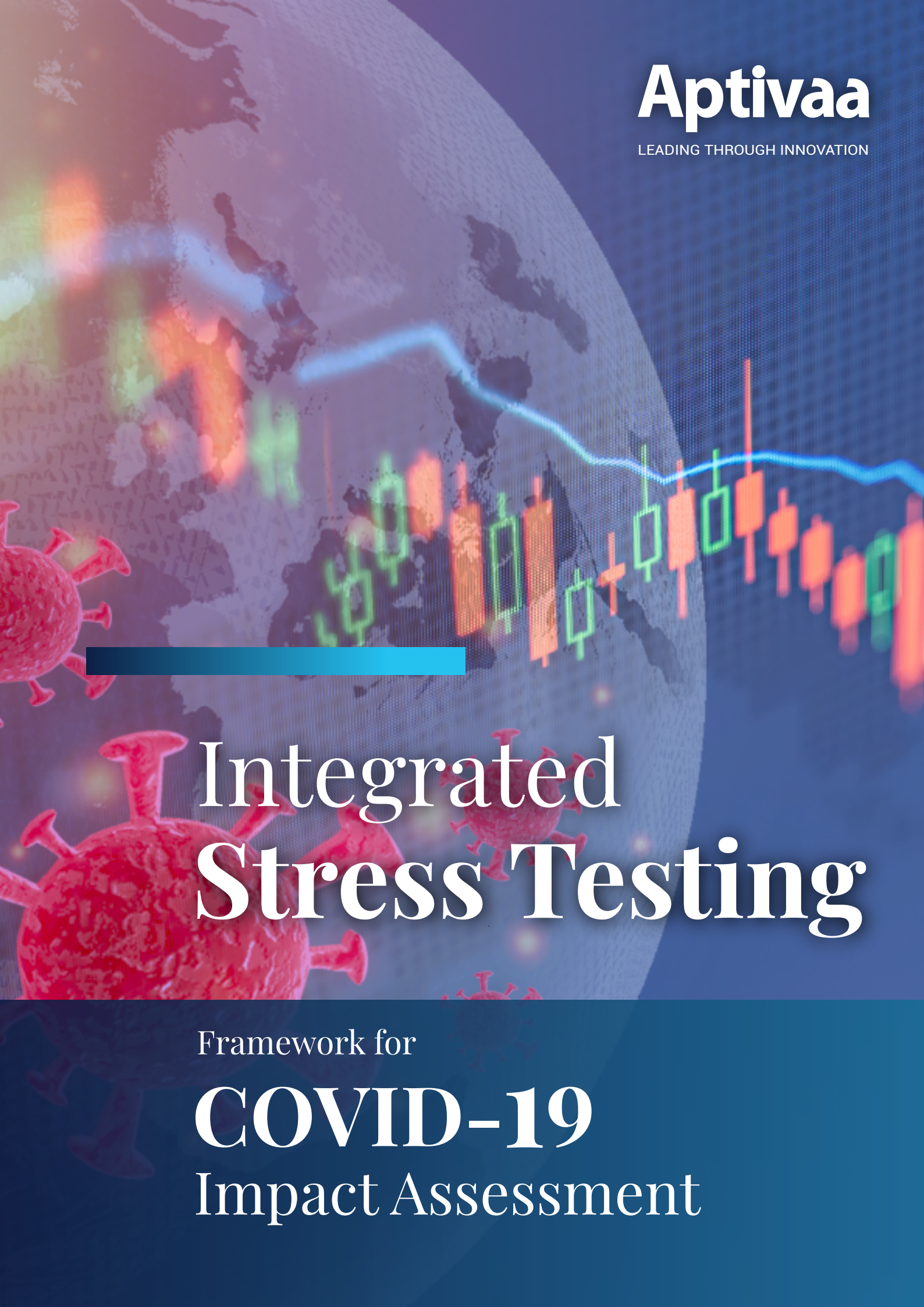


Aptivaa

LEADING THROUGH INNOVATION

Integrated Stress Testing

Framework for COVID-19 Impact Assessment

We are currently grappling with the biggest Black Swan event of our lifetime i.e. COVID-19. The crisis continues to unfold simultaneously in all parts of the world and never before have we experienced such widespread lockdowns of flights, trains, hotels, offices, restaurants and shopping malls, affecting life as usual across the globe. Financial institutions continue to do their best to provide essential services, but undoubtedly they will have to bear the direct and indirect repercussions of this unprecedented economic tsunami. The Central Banks are also monitoring the situation closely and have announced various relief measures in the form of stimulus packages and relaxed regulations. In current precarious and rapidly evolving situation, it is important for the senior management to be on the top of the risks in their portfolios. One of the most potent tools that the banks have in their arsenal is Stress Testing which allows them to simulate multiple hypothetical scenarios and assess the impact. The objective of this publication is to provide a practitioner's view on the evolution of stress testing practices and related challenges, along with the roadmap to an Integrated Stress Testing (IST) framework so that the same can be applied in times of COVID-19 crisis.

Introduction

Stress testing is the evaluation of a bank's financial position under extreme historical and plausible hypothetical scenarios. Stress testing today has become a key aspect of Risk Management and Regulatory Supervision at banks and other FIs. It has also served as an important tool to address the shortcomings of Pillar I Framework, especially the standardized approaches, and has increased the awareness regarding Risk Management among senior executives and the board. Besides identifying management actions, stress-testing outputs are used to enhance capital & liquidity contingency plans, risk mitigation and management techniques, decision-making processes in strategic and financial planning, pricing and risk appetite setting.

Evolution of Stress Testing Practices

Over time, we have seen many changes in the frameworks across several jurisdictions, prominent amongst them being (i) the greater use of analytical models, (ii) incorporation of scenario analyses and reverse stress testing, in addition to the sensitivity analysis, (iii) integrated approach to stress testing rather than silo based approach, (iv) strong governance as well as (v) linkage of results with business, capital and recovery plans.

Several regulators have also adopted standardized frameworks for stress testing to enable peer benchmarking and comparison. In such cases, regulators themselves specify the scenarios and key assumptions. Stress Testing started as an annual exercise in the initial versions of the regulations, but with time it has now become either a semi-annual or quarterly activity in most jurisdictions.

Regulators also expect the senior management and the board to have an active involvement in the challenge and approval process of the stress-testing framework and results. There have been instances where regulators have requested for proofs of any trainings conducted for them or have gone to the extent of scrutinizing the minutes of the approval committee meetings. It is expected that banks' stress tests be not only used for regulatory compliance but also feed into the management decision making for the setting of risk appetite, business and capital plans.

Another key development in the recent past is the issuance of a plethora of new regulations such as Basel III, Counterparty Credit Risk, IRRBB (BCBS 368), IFRS 9, ILAAP etc. These regulations have elements of risk analytics that overlap with the existing stress testing frameworks, exhibiting a big scope of alignment.

Examples include:

- Inclusion of IFRS 9 ECL related models and scenarios in Credit Risk Stress tests.
- Alignment of Interest Rate Risk Stress testing with the recent IRRBB BCBS 368 regulations that require usage of both economic value and the earnings-based measures, rigorous testing of key behavioral and modelling assumptions and additional scenarios on short rate shocks and twisters.
- Liquidity Stress testing could be enhanced in line with the ILAAP guidelines that involves quantitative assessment of wider spectrum of risks in addition to Pillar 1 Liquidity Ratios i.e. LCR and NSFR.

In addition, all the above-mentioned regulations require a forward-looking assessment involving forecasts of bank specific and market wide factors like balance sheet size, GDP, oil price, inflation, real estate prices and others. Ideally, a bank should have a consistent view of these factors across all such regulations at least in the base scenario.

Though on one hand, the stress testing and analytical practices have evolved in terms of coverage and sophistication, on the other they largely remain compartmentalized within key risk types. For instance, separate risk models for credit, market, interest rate and liquidity continue to run on their own sets of data, assumptions and methodologies in many banks. The individual impact of each risk type is then added to get the final losses or risk weighted assets (RWA).

Challenges in Integrated Stress Testing

Instead of looking at the key risks in silo, it is time for banks to start adopting an Integrated Stress Testing (IST) Framework where the scenarios, data and risk models across the organization are linked on the basis of their interdependencies. However, this involves several challenges:

- Risk Models and data are often scattered across multiple platforms & excel sheets. Either they need to seamlessly talk to each other or migrate to a single model deployment engine.
- Difference of approaches in regulatory capital models (Standardized Approach) and other internal approaches being used for Stress Testing makes overall integration difficult.
- Moreover, analytical frameworks like IRB, IFRS 9, IRRBB, ILAAP, ICAAP & Stress Testing are often owned by different teams across the banks, so any integration requires full transparency and harmonius coordination among all relevant stakeholders.

- The objectives, timing and horizon of these exercises often don't align, and to a certain degree may be conflicting in nature. For example – IFRS 9 ECL allows optimistic scenarios whereas usual stress testing requires multiple pessimistic scenarios.

- The assumptions related to dynamic balance sheet also add to the complexity.

- Risk Aggregation is another big hurdle in integration of frameworks and results. Many regulators are not comfortable with the idea of allowing diversification benefit, as there is lack of data to determine inter-risk or intra-risks correlations.

Integrated Stress Testing Framework

In the context of above-mentioned challenges, it is difficult to have an ideal IST framework where all the data and models are either seamlessly connected or replicated. Hence, we present a practical framework to implement Integrated Stress Testing (IST).

One of the foremost functions is to form a taskforce for IST, including representatives from various risk divisions, risk data/solutions and financial reporting led by an experienced Risk Analytics personnel. An exercise of such magnitude requires work in close coordination over a duration of 6-8 weeks as the numbers go through multiple rounds of stakeholders discussions, feedbacks and optimizations, before the final sign-off at the Board level.

The policy and regulations broadly define the horizon, frequency and key principles of the exercise which are supposed to be consistent across banks in a particular country. However, At the Implementation level, large differences can still be observed in the sophistication and granularity at which the exercise has been carried out.

The diagram on the following page represents the best practice Integrated Stress Testing (IST) Framework.

Integrated Stress Testing (IST) Framework

A. Data Model

- Customer / Portfolio data along with key dimensions
- Default Data
- PD Curves
- LGD values
- CCFs values
- Trading Book
- Investment Book
- Operational Losses
- Macroeconomic Data
- Pillar 1 Reports
- IFRS 9 Models
- Econometric Models
- ALCO Pack
- ILAAP Models
- Behavioral Models
- Balance Sheet Growth / Forecasts (3-5 years)

B. Scenarios Design

- COVID-19
- Low Oil Price
- Global Recession
- Regional Recession
- Fall in tourism
- Regional War
- Postponement of Expo (UAE)
- Cancellation of Hajj (KSA)

C. Macroeconomic Indicators

- Oil Price
- GDP Rate
- Fiscal Spend
- Inflation
- Unemployment Rate
- Interest Rate
- Stock Market Index
- FX Rates
- Industry Indices
- Real Estate Price
- Credit Growth
- No. of Tourists arrival
- Hotel Occupancy Rate

D. Stress Severity

- Base Case
- Mild Stress
- Moderate Stress
- Severe Stress

E. Risk & Business Factors

- Rating Downgrades / PD increase
- IFRS 9 ECL Stage Migration
- Top corporate exposure defaults
- Top Sector defaults
- Drop in collections
- Fall in collateral Value
- Deposit Runoff
- Limit Drawdown
- Delayed Repayment/Rollover
- Step-in Funding Calls
- FX rates
- Valuation / MTM Losses
- Changes in Interest Rates
- Operational Losses
- Cyberattack Loss
- Reputational Event
- Credit Growth

F. Balance Sheet Simulations

- Simulate Cashflows with adjustments due to loan moratoriums, rollovers, deposit runoffs, limit drawdowns and other relevant factors
- Budget / Growth / Forecasts for base and stress cases (3-5 years)

G. Key Metrics

- Capital Adequacy Ratio (CAR)
- Liquidity Coverage Ratio (LCR)
- Net Stable Funding Ratio (NSFR)
- Loans to Deposit Ratio (LDR)
- NPL & Provisioning Ratios
- NII & Profitability
- Liquid Assets Ratio (LAR)
- Economic Value of Equity (EVE)

H. Management Actions

- Reduce growth forecasts
- Issuance of AT1 and T2 Capital
- Reduce Opex /Capex
- Reduce Dividend Payout
- No Management Bonus
- Reduce Credit Limits
- Sale of investment portfolio
- Run-down of interbank placements
- Sell loan portfolio
- Raising customer deposits at higher rates
- Interbank borrowings

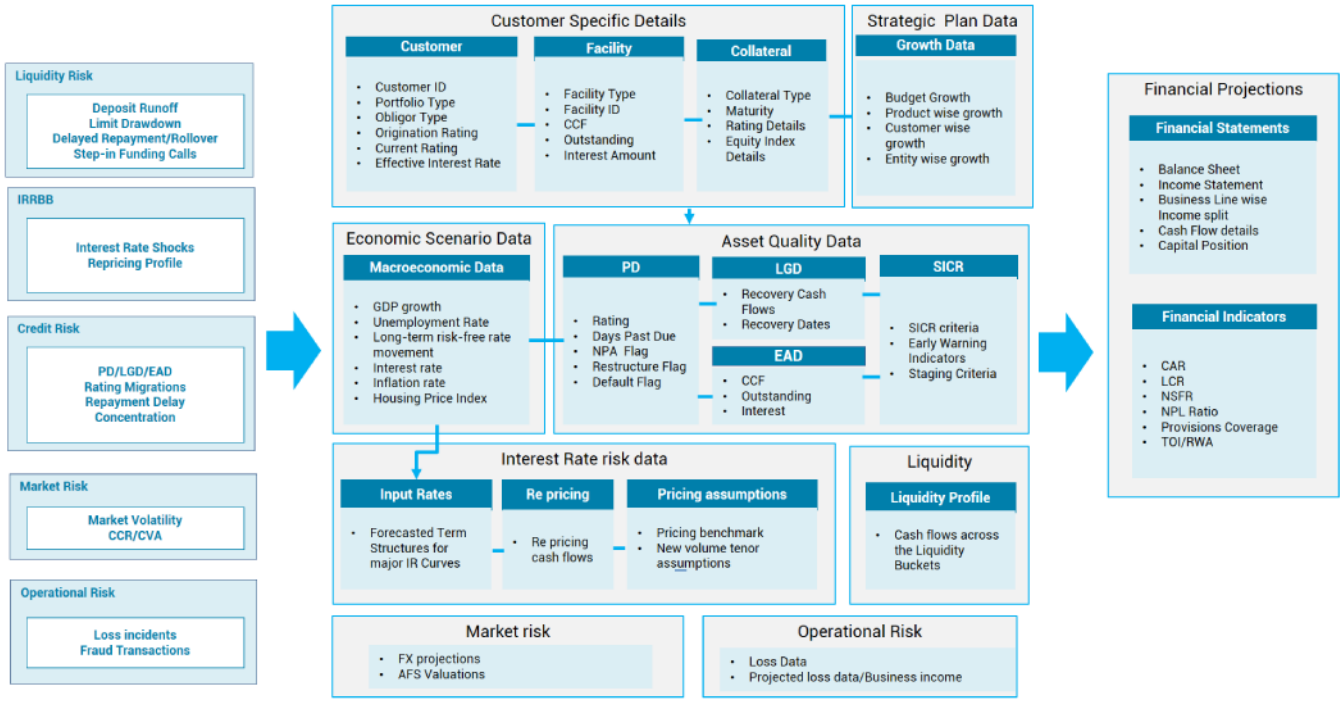
Components of Integrated Stress Testing

A. Data Model

Lack of adequate quality data is often cited as one of the challenges to the credibility of IST sophistication. The following aspects are important:

- The granularity of data model (facility / customer / product /pool level).
- Clarity on type of data required: Financials & Position data (as of reporting date), Forecasts (Growth & Budget for 3-5 years) and Historical Data (for macro-indicators, default, NMD behavior etc.)
- Leveraging of existing risk models and tools to the maximum extent. Re-collection of all historical data is unnecessary, if other teams have already built PD /econometric models in IFRS9 ECL or behavioral models in ILAAP.
- Ideal plan should be to collect as much granular risk data as possible and compute all metrics within IST engine itself. However, if there are other risk engines to compute key metrics, then at the minimum, the risk factor sensitivities need to be imported instead of computed numbers.
- In practice, it is difficult to get a golden data source for all the required parameters. Hence, it is important to identify all the relevant source systems and excel files, reconcile them and obtain sign-off from responsible parties.

A high level illustrative **IST Data Model:**



B. Scenarios Design

The typical practice is to define Idiosyncratic scenarios for key risks along with several Systematic scenarios. They may be either based on historical experience or can be hypothetically conceptualized and are typically defined in the form of crisp and short qualitative statements. This task is handled by an economist in large banks whereas smaller banks usually rely on reputed third party research reports. Few regulators also provide a list of minimum scenarios that need to be covered.

Sample scenarios for the current COVID-19 situation can be conceptualized as follows:

Mild Scenario	Moderate Scenario	Severe Scenario
The crisis ends by Q2 (June-20) with no new corona cases and all lockdowns lifted	The crisis ends by Q3 (Sept-20) with no new corona cases and all lockdowns lifted in a staggered manner	The crisis ends by year end with no new corona cases and all lockdowns lifted in a staggered manner
Economic impact largely cushioned by govt. stimulus and regulatory relaxations	Economic impact somewhat cushioned by govt. stimulus and regulatory relaxations	Large economic impact as govt. stimulus and regulatory relaxations fall inadequate
Mild Global Recession	Global Recession with longer lockdowns in major economies like US, EU & Australia.	Deep Global Recession with longer lockdowns in major economies like US, EU & Australia.
One quarter of revenue loss, temporary pay cuts but no big layoffs	Two quarters of revenue loss, permanent pay cuts with big layoffs in select industries like travel and entertainment	Mass layoffs across industries
No major defaults due to loan moratoriums	Big impact on select Industries	Spike in defaults
Cancellation of all events in Q2 (Expo, Grand Prix, Hajj etc,)	Cancellation of all events in Q2 & Q3 (Expo, Grand Prix, Hajj, Shopping Festivals etc,)	Zero rate regime
Customer confidence is recovered in Q3	Customer confidence starts to build up in Q4	Cancellation of all tourism and entertainment avenues to continue in early 2021
		Bankruptcy/Stressed sales of assets

*The above scenario definitions are only for illustration purpose and no way are to be taken as an official view of the company on COVID-19 situation.

C. Macroeconomic Indicators/Data

- The qualitative scenarios are then broken down into all relevant macro indicators that may be impacted. This can either be done through historical research, workshops with management and business heads or expert data providers. It is suggested to create a mapping table for clear understanding.

Risk Factors	Scenario 1	Scenario 2	Scenario 3
• Rating Downgrades / PD increase	Y	Y	Y
• IFRS 9 ECL Stage Migration	Y	Y	Y
• Top corporate exposure defaults	Y	N	Y
• Top Sector defaults	Y	N	N
• Delayed Repayments/ Financing Rollover	Y	N	N
• Drop in collections	Y	N	N
• Fall in collateral Value	Y	N	N
• Deposits Runoff	N	Y	Y
• Stalled projects	Y	N	N
• Valuation / MTM Losses	Y	Y	N
• FX rates shock	Y	Y	N
• Changes in Interest Rates	Y	Y	N
• Limits Drawdown	N	N	Y
• Step-in Funding Calls	N	N	N
• Operational Losses	Y	N	N
• Cyberattack on bank	Y	Y	N
• Reputational Event	N	Y	N
• Key Staff Quarantined	N	Y	N

- The historical data for macro indicators should be collected at least on quarterly frequency to enable more data points for econometric modeling.

- Try to maintain an exhaustive list of indicators in the database as some indicators which are not useful today may be relevant in the future.

- One of the key tasks is to prepare a base forecast of all the macroeconomic indicators for the next 3-5 years. This requires a combination of research of central bank/IMF publications, reputed research reports and/or subscription to expert data providers. This task is again best suited for an economist. Few regulators also provide a forecast of key indicators which are safe to use at least for regulatory submissions.

D. Stress Severity

The typical market practice is to define a base case and three stressed scenarios. However, this may differ across regulators. The following suggestions maybe useful -

- Define the base case and stress values of all macro indicators.
- It is observed that banks' budget or growth forecasts don't clearly list the assumptions under which they have been developed, so the same needs to be understood.
- Parameterize the input process of entering stress values with a flexible front end, as these may go through multiple iterations based on feedback from all the stakeholders.

E. Risk & Business Factors

The core aspect of the IST exercise is to identify all the material risk and business growth factors.

- Identify and map the risk and business factors with macroeconomic indicators. This can be mapped either one-to-one or one- to-many as the case may be.
- Define the relationship between these factors and macroeconomic indicators. The same should either be derived statistically using market standard econometric practices or defined judgmentally or by subscribing best practice models provided by third party vendors/consultants. Rather than reinventing the wheel, it is suggested to use existing econometric models in IFRS9 ECL, IRRBB or ILAAP framework.

Econometric linkage of Macroeconomic Drivers to Risk and Business Factors

$PD_{Corporate} = X*Oil\ Price - Y*GDP + C$

$PD_{Personal\ Loans} = X*Inflation + Y*Unemployment + C$

$PD_{Mortgages} = -X*HousePriceIndex + Y*Unemployment + C$

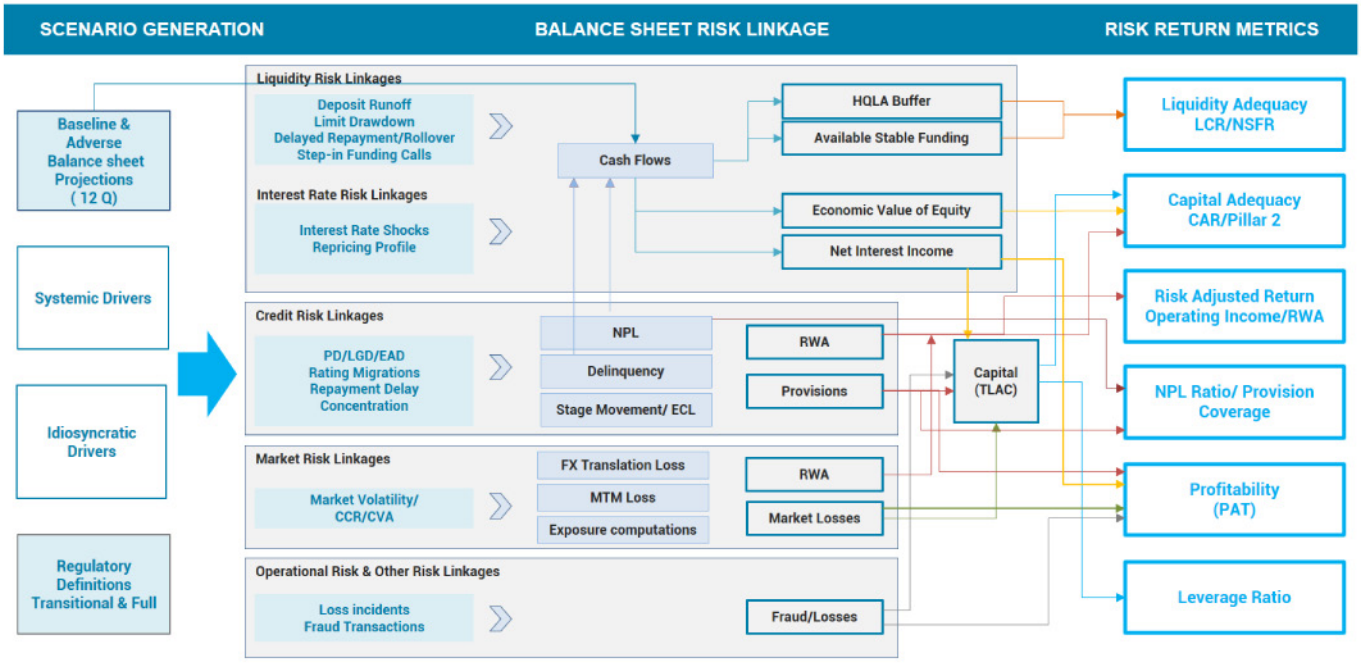
$NMD\ Run\ off\ Rate = X*Interest\ Rate + Y*Unemployment + C$

$Credit\ Growth = X*GDP + Y*FiscalSpend + C$

$Prepayment\ Rate = fn\ (DealRate - BenchmarkRate)$

- Identify linkages/dependencies between risk factors/types so that all underlying models are aligned in approach/assumptions and shock impact is not counted multiple times. In absence of correlations amongst various risk factors, several key interlinkages may be identified on judgment basis.

Integrated Stress Testing – Risk Linkages (Illustrative)



For example, the impact of credit stress because of increase in delinquencies/non-performing loans and reduction of available Tier 1 and Tier 2 capital is taken into consideration to assess the impact on LCR and NSFR ratios. The liquidity stress horizon is assumed to correlate with credit stress in such a way that the full impact of credit stress during a year is considered in the liquidity stress testing. Further, the impact of liquidity stress through increased cost of funding to rollover deposits and management actions required to cover for stressed run-offs can be included in reassessing capital adequacy ratios.

F. Balance Sheet Simulations

- Generate principal and repricing cash flows with granular position data.
- Factor in adjustments due to loan moratoriums, rollovers, deposit runoffs, limit drawdowns and other relevant factors.
- Feed base year cash flows into computations of other dependent metrics like loan losses (ECL).
- Forecast stressed financials for the next 3-5 years after incorporating budgeted growth (at least at the same level of detail as the gap statements), new business assumptions (product wise maturity profiles, pricing basis and spreads) and other strategies.

- Feed base year final stress outputs into base case computations for the next year and so on.
- Allow the select Management Actions to be plugged within the forecasts from front-end of the solution.

G. Key Metrics

The impact of Stress Testing is computed for key regulatory and internal ratios like provisioning, liquidity and capital under base case and stressed scenarios. It also provides critical inputs for banks' Contingency Funding Plan and Recovery Plan. Furthermore, there should be a clearly defined Management Action Plan based on the Risk Appetite triggers. It may lead to iterative adjustments in strategic plan like no dividend payment or management bonus, reduction of credit growth, asset sale or raising of additional capital etc. The end objective is to make sure that the forecasted final key metrics remain within control.

H. Management Actions

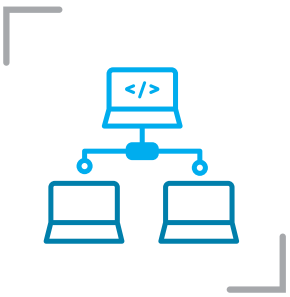
The Bank's management shall formulate realistic actions (board-approved strategies) as required, vis-a`-vis the following:

- The context of the situations and specific circumstances, including external factors under which the management actions are unlikely to be feasible.
- Whether the actions are consistent with the risk appetite or tolerance level set by the Board.
- Whether the bank has adequate financial resources and operational capabilities to undertake such management actions.
- Constraints by supervisory or regulatory requirements, or any market restrictions.
- The possibility of other market participants adopting similar strategies, which may reduce the effectiveness of the intended outcome.
- Management actions shall be based on careful analysis and deliberation by the Board and senior management.
- The Bank shall ensure that effective monitoring mechanisms are in place to promptly activate management actions based on established triggers.
- It is important to completely parametrize Management Actions module as the action plan provisioned under base scenario may fall inadequate. But in case forecasted Risk Metrics breach the defined Risk Appetite, then it may be required to add or modify the management action plan. The extent of additional management actions may vary and it is typically an iterative process.

How should an ideal IST Engine look like?

An ideal IST solution should be able to combine all the underlying components including data, risk factors, models and scenarios to generate output in desired formats. The high-level functionalities of the key modules are listed below:

IST Components	Key Functionalities
Data Module	◆ Ability to define stress test data model and modify it on periodic basis ◆ Multiple Data Files Import Facility ◆ Data Quality Assessment & Massaging ◆ Reconciliation Capabilities ◆ Easy to integrate with existing datamart(s) and other risk systems
Scenarios Designer	◆ Ability to configure a master list of risk and balance sheet factors ◆ Ability to define multiple scenarios & map them with relevant factors ◆ Ability to define key shock & growth values of factors from front-end ◆ Ability to store the historical scenarios
Consolidation Module	◆ Consolidates and integrates results across multiple risk areas ◆ Projections under both baseline and stress scenarios computed ◆ Reporting in line with regulatory requirements ◆ Dashboards with charts and smart commentary ◆ Summary of scenarios, key assumptions & Management Action Plans ◆ Key Metrics in base and stressed scenarios (Traffic Light as per Risk Appetite)
Balance Sheet Management	◆ Integrated balance sheet model with comprehensive coverage of balance sheet risks ◆ Flexibly define balance sheet categories in a tree structure ◆ Ability to define risk and return metrics through the UI in a transparent manner which can easily be validated and audited ◆ Detailed logs on configuration changes and metric definition changes ◆ Supports both Static and Dynamic approaches to forecast risk and return metrics. ◆ Ability to simulate cash flows with adjustments due to loan moratoriums, rollovers, deposit runoffs, limit drawdowns and other relevant factors ◆ Supports configuration of multiple business plans at various granular levels and entities ◆ Projections automatically maintain stable business mix ◆ NII Accruals over flexible model period definitions ◆ Ability to simulate defined Liquidity Metrics , Liquidity & Interest Rate Sensitivity Gaps ◆ Ability to configure multiple standard and non-standard rate shock projections ◆ Standard shocks included regulatory definitions like parallel, short rate and twisters
IFRS9 ECL Calculator	◆ Ability to simulate ECL losses under IFRS9/CECL guidelines in various scenarios at granular level ◆ Macroeconomic forecasting of loss parameters ◆ PIT Transformations – PD, LGD and EAD ◆ Lifetime and 12 month ECL computation (IFRS9 vs CECL requirement) ◆ Stage Assessment rules
RWA Calculator	◆ Ability to compute Basel Regulatory RWA & Capital Ratios for Credit, Market and Operational Risks for current and projected portfolios. ◆ Both Standardized and Advanced IRB Approaches covered for Credit Risk ◆ Market Risk (Standardized Approach or Advanced as applicable) ◆ Operational Risk (The Standardised Approach) ◆ Control over the limit and collateral allocation module via business rules, and/or other optimization routines ◆ Allocation ability at customer as well as facility level



Deployment Options

The following aspects are important for design and implementation of an efficient IST solution:

- Stress Test engines at most banks are still spreadsheets-based, the reason being lack of availability of standardized third-party vendor systems due to variation in ST frameworks observed across banks. Thus, the same has to be typically custom built for each bank on a suitable analytical platform, which is a complex and expensive strategy from short term compliance perspective. Therefore, many banks adopt a tactical approach to meet immediate compliance deadlines.

- The excel based tool has little benefit in terms of flexibility and cost, but it has huge limitations with respect to the amount of data it can hold, complexity of models it can run, ability to integrate all IST components and simulate balance sheet in multiple scenarios. Thus, for implementing Integrated Stress Testing, banks may need to move from excel to robust IST solutions.

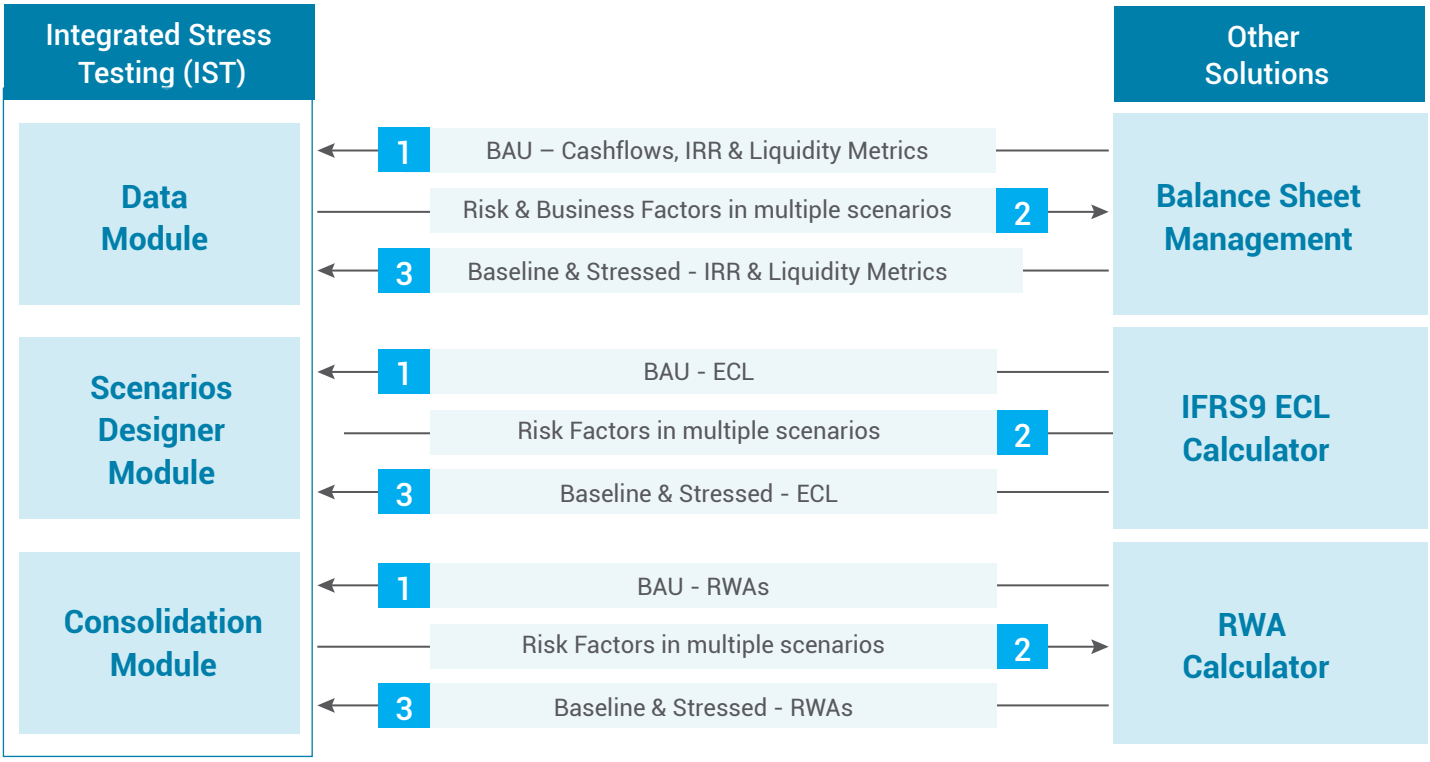
- It is advised to maintain consistency between the data model and input/output formats of the core IST engine and other key risk engines, so that the entire process is seamless to the extent possible.

- The scenario generation, risk factors and portfolio growth values should be parameterized to enable quick iterations based on management and board feedback.

- It is practically impossible to deploy all the risk models within an IST engine. It is of utmost importance to decide the metrics to be computed within the IST engine, and the computations for which the bank will continue to rely on existing risk engines like Regulatory Capital (RWAs), IFRS9 ECL, ALM Solution (IRRBB & Liquidity Risk) etc.

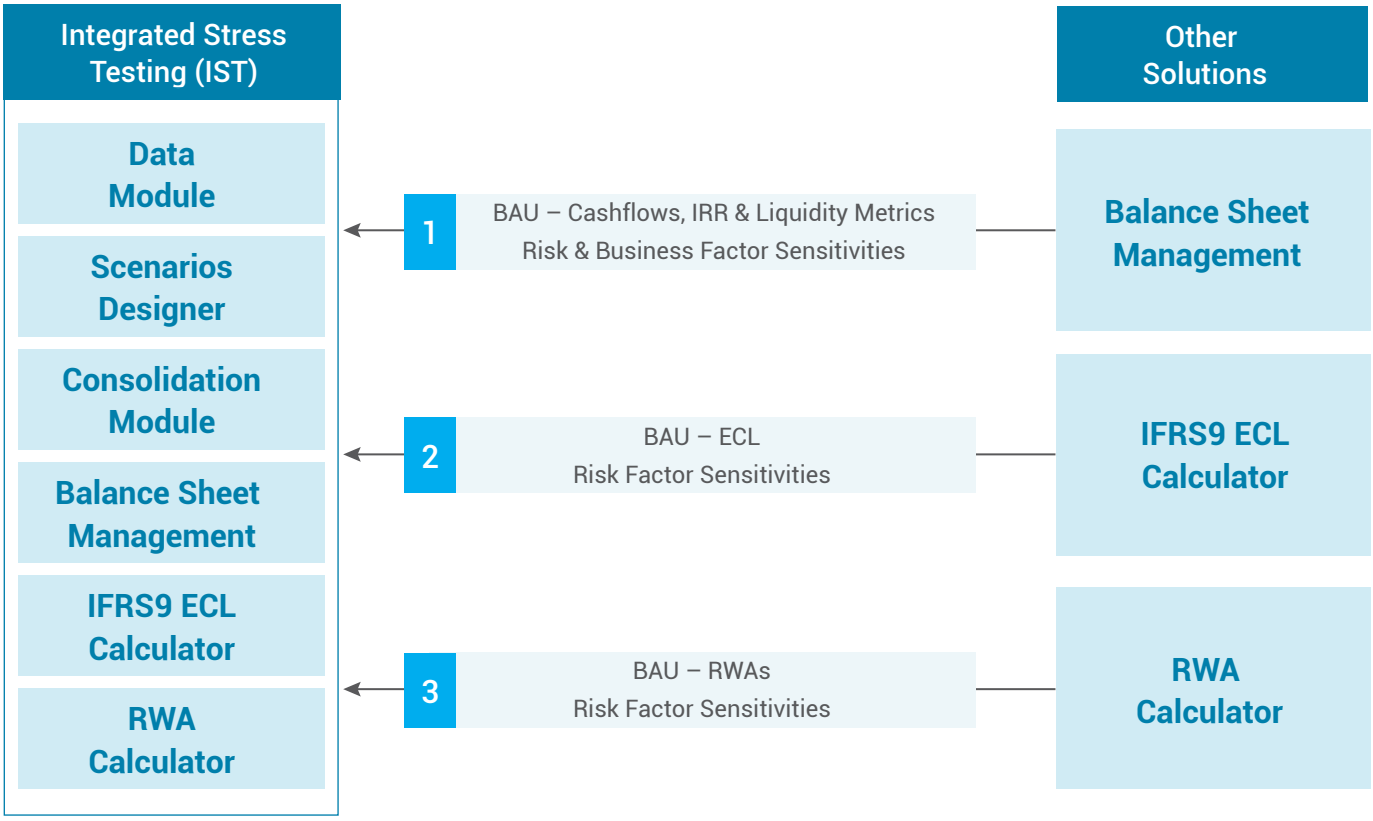
The following IST deployment options emerge in increasing order of sophistication of the framework:

Deployment Option A – Fragmented ST



- Stress Testing (ST) is primarily a consolidation engine along with scenario generation function
- Risk & Business Factors in multiple scenarios are pushed to external supporting risk and balance sheet management systems to generate BAU (Business As Usual), Baseline & Stressed computations
- ST utility is designed to aggregate the several worksheets and metrics for each scenario or risk type
- This type of fragmented deployment poses huge compatibility issues in terms of data, granularity of computations, scenarios and methodologies across systems
- Integration of ST components gets constrained and computations are often time taking as information flows to and fro across multiple systems and stakeholders, with reconciliation checks each time

Deployment Option B | Partially Integrated ST | Sensitivity Approach



- In addition to consolidation and scenario generation functions, ST utility also has inbuilt high level functionalities of ECL, RWA and Balance Sheet computations based on risk & business factor sensitivities and certain approximations.
- BAU computations and factor sensitivities are computed in other risk & Balance sheet engines but stressed computations are done within IST engine by multiplying shock values with sensitivities, often at portfolio level.
- This allows integration to some extent at portfolio level but it not only involves several assumptions/ approximations but also lack granularity to be sliced & diced across various dimensions.

Deployment Option C | Integrated ST | Full Simulation Approach

Integrated Stress Testing (IST)

- Data Module
- Scenarios Designer
- Consolidation Module
- Balance Sheet Management
- IFRS9 ECL Calculator
- RWA Calculator

- IST solution is self-sufficient to deploy all the scenarios, models, assumptions and metrics at most granular level
- This offers the best user experience of straight through processing across all modules with granular real time computations performed through interactive dashboard.
- For banks already having certain legacy solutions, this type of deployment option may result in parallel challenger infrastructure which has its own pros and cons.

Need for an Integrated Stress Test Engine

The shift towards sophisticated analytical models has resulted in enhanced focus on risk measurement and it's linkages with business decision making. In such stressful times of COVID-19 situation, it is therefore the need of the hour that banks review and update their existing stress testing and risk analytics frameworks including data, models, resources, governance and tools. It is vital that banks start to make a shift from existing tactical excel spreadsheets-based toolkits to a more robust analytical IST solution. In the current times, when black swan events are becoming a frequent norm, one can't wait for the situation to become normal to decide next course of action. The management needs to equip itself with an Integrated Stress Testing solution for quick balance sheet simulations and decision making.

We at Aptivaa continually strive to enhance our Stress Testing frameworks in line with global regulations and best practices. We have developed a range of advisory, analytical and IT solutions for implementing stress testing frameworks at several financial institutions. We look forward to hearing back from you on this subject, the challenges faced by you or any suggestions that you may have. Please feel free to contact us at info@aptivaa.com.

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Aptivaa

Aptivaa is an established services provider, offering comprehensive analytical solutions, for clients in banking, insurance and other financial services. Globally, we have worked with several clients to enable them to successfully navigate the ever-changing regulatory & business environment in the area of Financial Risk Management.

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