

GRC ANALYTICS

EXHAUSTIVE COVERABLE, USER FRIENDLY AND FLEXIBLE OFFERING

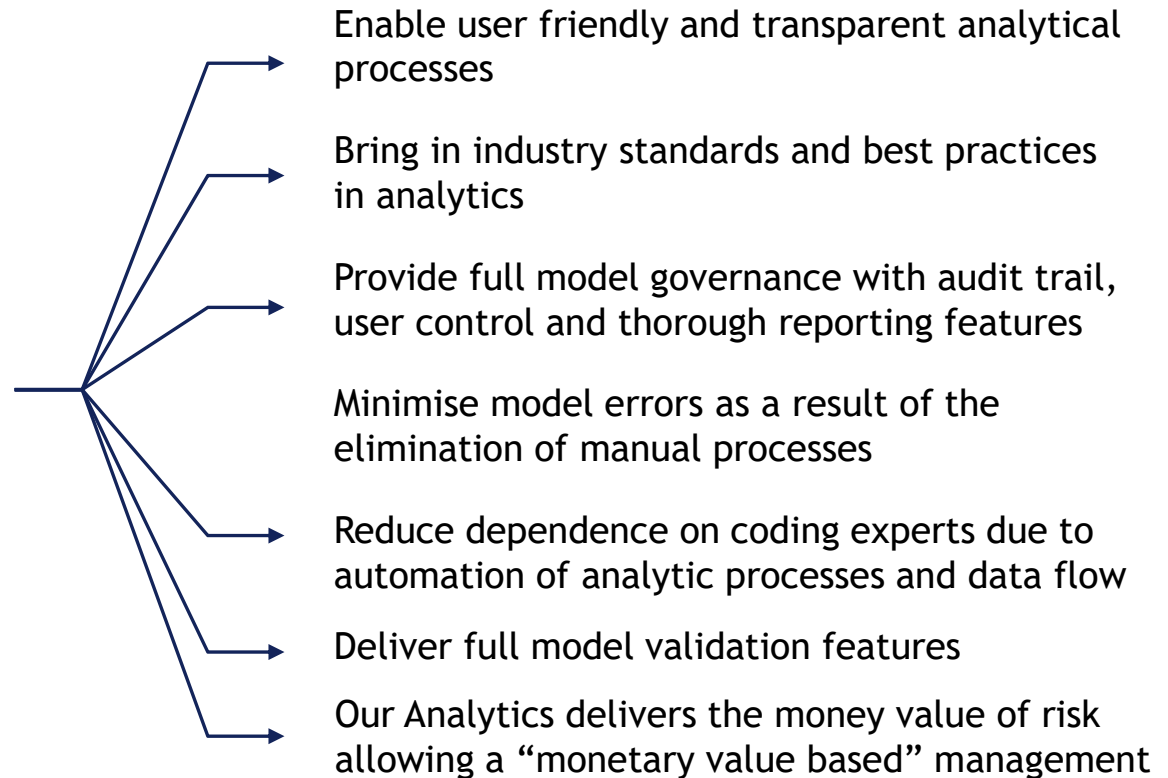
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APRIL 2020

THE ANALYTICS BOUTIQUE
Analytics made friendly
A TRUE NORTH PARTNERS company

The Analytics Boutique (TAB) is a risk analytics software company that builds user friendly analytics solutions to uplift the risk capability of your institution

We believe that analytics teams, rather than designing and developing code, should be focused on value added tasks, being assisted by user friendly tools with full model governance, integrity of data flows between analytical processes and mechanised report generation

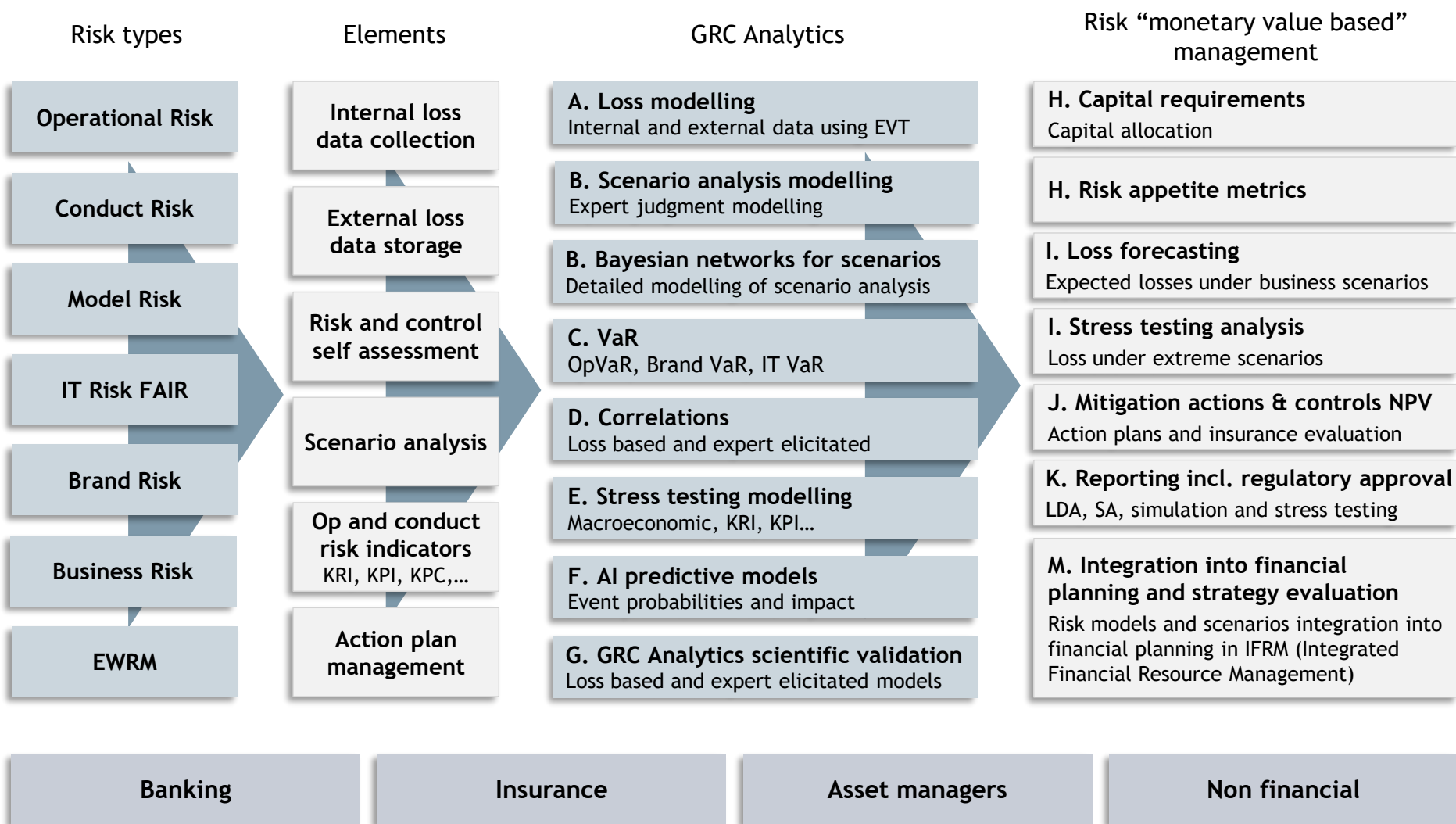


We help organisations move from data to action

Award winning TAB's Operational and Conduct Risk offering represents a breakthrough addressing most burning issues in judgment based risk assessments

Cognitive biases mitigation	<ul style="list-style-type: none"> Structured Scenario Analysis is designed to mitigation multiple biases: need for closure, herding or group thinking, confirmation biases, anchoring biases, authority biases and other
risk measurement & mitigation jointly	<ul style="list-style-type: none"> In Structured Scenario Analysis, risk mitigation is evaluated together with risk evaluation, using a scientific method based on calculating the money value of risk
Money value of risk	<ul style="list-style-type: none"> By on-the-fly Monte Carlo simulation, it calculates the cost of assuming risks and compares it with the savings of hedging/controlling such risk providing the NPV of mitigation actions
Scientific validation of expert judgment	<ul style="list-style-type: none"> Structured Scenario Analysis implements performance based expert judgment which allows to validate responding experts based on limited available information
Efficiency features and for engaging your organization	<ul style="list-style-type: none"> It enables a workflow, email sending system, expert responding progress page, reminders, answers automated aggregation, extensive reporting, and more
Correlation approach	<ul style="list-style-type: none"> Structured Scenario Analysis provides a solid cross-scenario correlation approach based on expert judgment Correlations are very transparent, intuitive and easy to justify
Robust and stable capital calculation	<ul style="list-style-type: none"> Structured Scenario Analysis integrates different sources of data (ILD, ED and BEICFs) to compute a more stable capital charge, adding information of the distribution tails, reducing the volatility of capital estimates
Analytics available to 1st line of defence	<ul style="list-style-type: none"> Structured Scenario Analysis provides, to the first line of defence, the cost of risk, saving from mitigation and NPV of action plans required investing, encapsulating all modelling complexities thanks to AI algorithms
Strong governance	<ul style="list-style-type: none"> User control, audit trail, roles and activities differentiated by user and other
Fully flexible	<ul style="list-style-type: none"> Flexible forms, user defined number of loss collection processes, indicators, configurable workflow, etc.

The Analytics Boutique's covers the widest GRC Analytics spectrum



We are well recognised in the GRC industry for our award winning offerings in the op risk management, measurement and stress testing space

2016/17 industry award recognition with 5 awards...and 5 awards in 2018/19



By Risk.Net (Risk Magazine)



By InsuranceERM

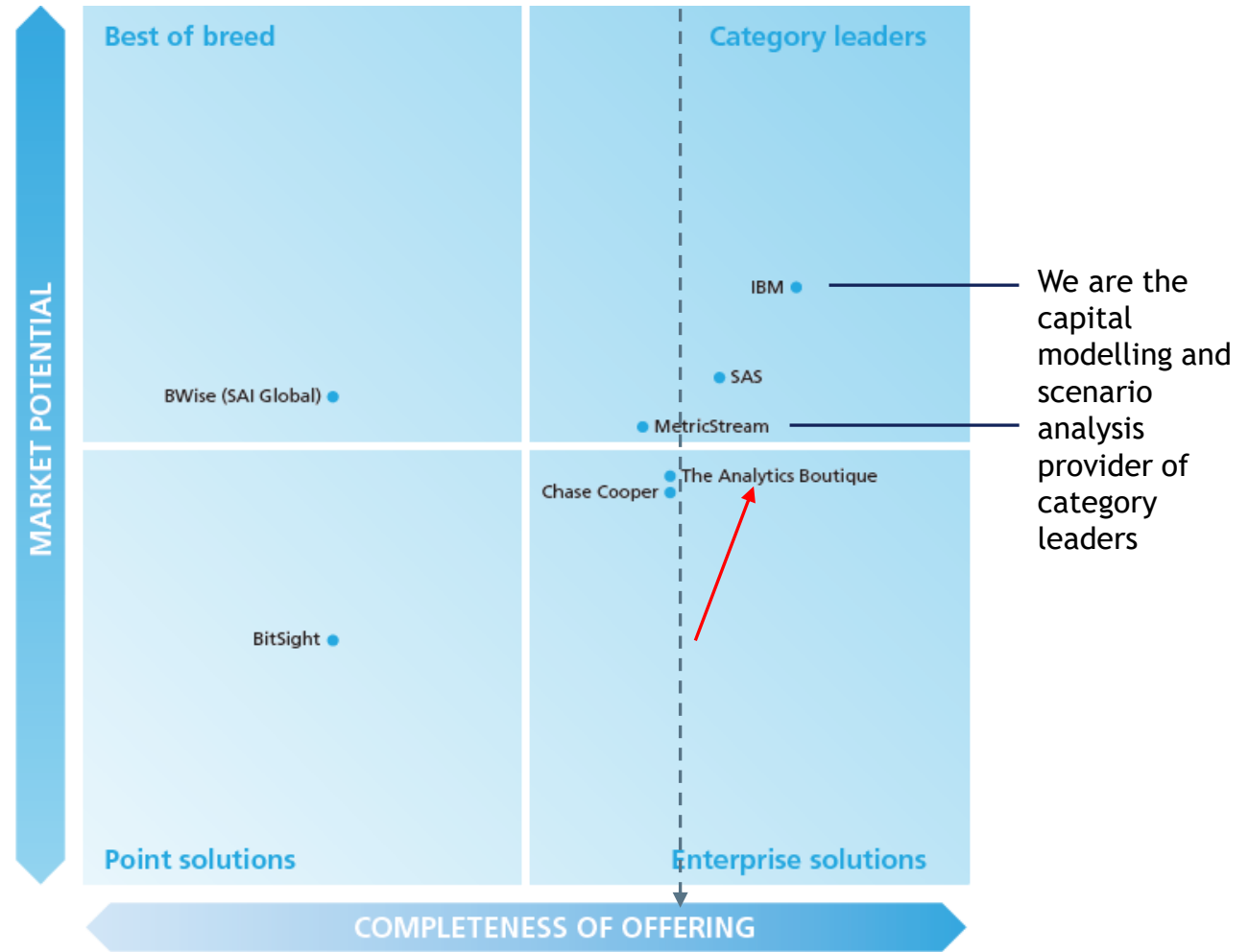
Thanks to our capital modelling technology we are the leader of the Enterprise solution in the GRC Analytics (broad) category



Enterprise GRC Solutions, 2019

Market Update and Vendor Landscape

Chartis RiskTech Quadrant® for GRC analytics solutions, 2019

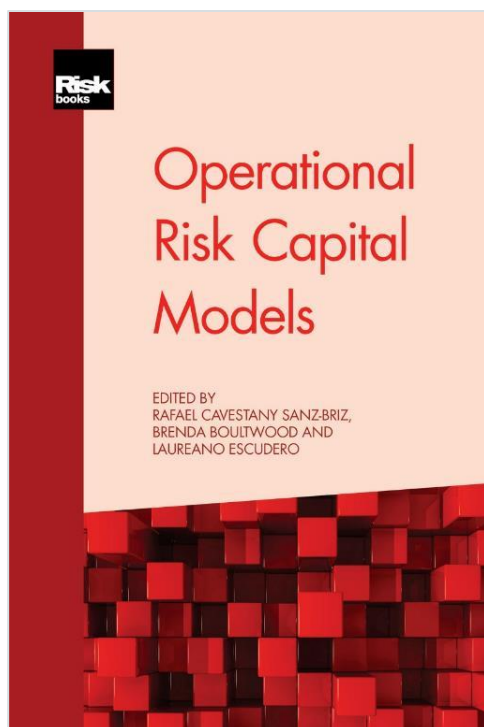


We are thought leaders in the risk industry and have made significant contributions to the advancement of the GRC Analytics industry

"I found the quantitative methods presented in "Operational Risk Capital Models" to be not only rigorous, but also understandable and actually useable and useful, which can be said of shockingly few books treating operational risk. Amidst a wasteland of operational risk management pie charts and unactionable and subjective heat maps, books like this are an oasis of practical, applied solutions for capital estimation and stress testing. If your objective is to directly and measurably mitigate and manage operational risk using scientifically defensible, objective methodology, as opposed to red-amber-green traffic 'analyses,' the methods herein are the kind you need."

J.D. Opdyke, GE Capital

RiskBooks, Incisive Media



Book description	Book details	Editor biography	Table of contents	Testimonials
Testimonials <i>"The book covers in detail all the building blocks of operational risk modelling with a very pragmatic, step-by-step, view from industry practitioners so the reader can see how the operational risk capital is actually calculated and stress tested. The authors move from the technicalities of credit calculation to the integration of risk capital into the strategic and tactical decisions of the financial institutions. In my view, this book is a strong contribution to operational risk management in this new era."</i> Marcelo Cruz, Professor, New York University Stern School of Business and Editor-in-Chief, Journal of Operational Risk				
Customer Reviews Average customer reviews for Operational Risk Capital Models ★★★★★ 7 Reviews Add Your Review ★★★★★ Meeting the theoretical with the practical The book provides an excellent view into how to practically model operational risk, showing alternative methods that have all been tried and tested. While many theoretical texts are out there, few are able to distill down into something pragmatic enough to implement in practice being able to trade off statistical reliability with issues of lack of data and expert judgement. This book covers these issues and a full range of possible ways depending on what is available to the modeler. Review by Andrew Morgan - Quantitative Risk Analyst, Old Mutual plc, 28/10/2015 ★★★★★ A very practical and implementable approach to operational risk modelling The book includes interesting and innovative topics such as structured scenario analysis, techniques for determining optimal level of granularity for modelling, methods for qualitative derivation of correlation, and the modelling of correlation between frequency and severity. The outputs of proposed quantitative methods can be integrated into daily risk management practices and performance measures, making the book very relevant for modern day financial institutions. Review by Flippie Snyman, Enterprise Risk Management, FirstRand, 26/10/2015 ★★★★★ A practical book to start building Op Capital models An easy to read book that covers all relevant topics on how to build operational risk capital models. Its easy to pick up this book and start designing and planning your model implementation. The authors are practitioners in the field and hence the book gets to implementation issues quickly with practical ways to solve common challenges we face in the course of our work. I recommend this book to anyone wanting to start implementing models.				

Marcelo Cruz, Morgan Stanley

The Actuary Magazine, Society of Actuaries

FEATURE
STRUCTURED SCENARIO ANALYSIS

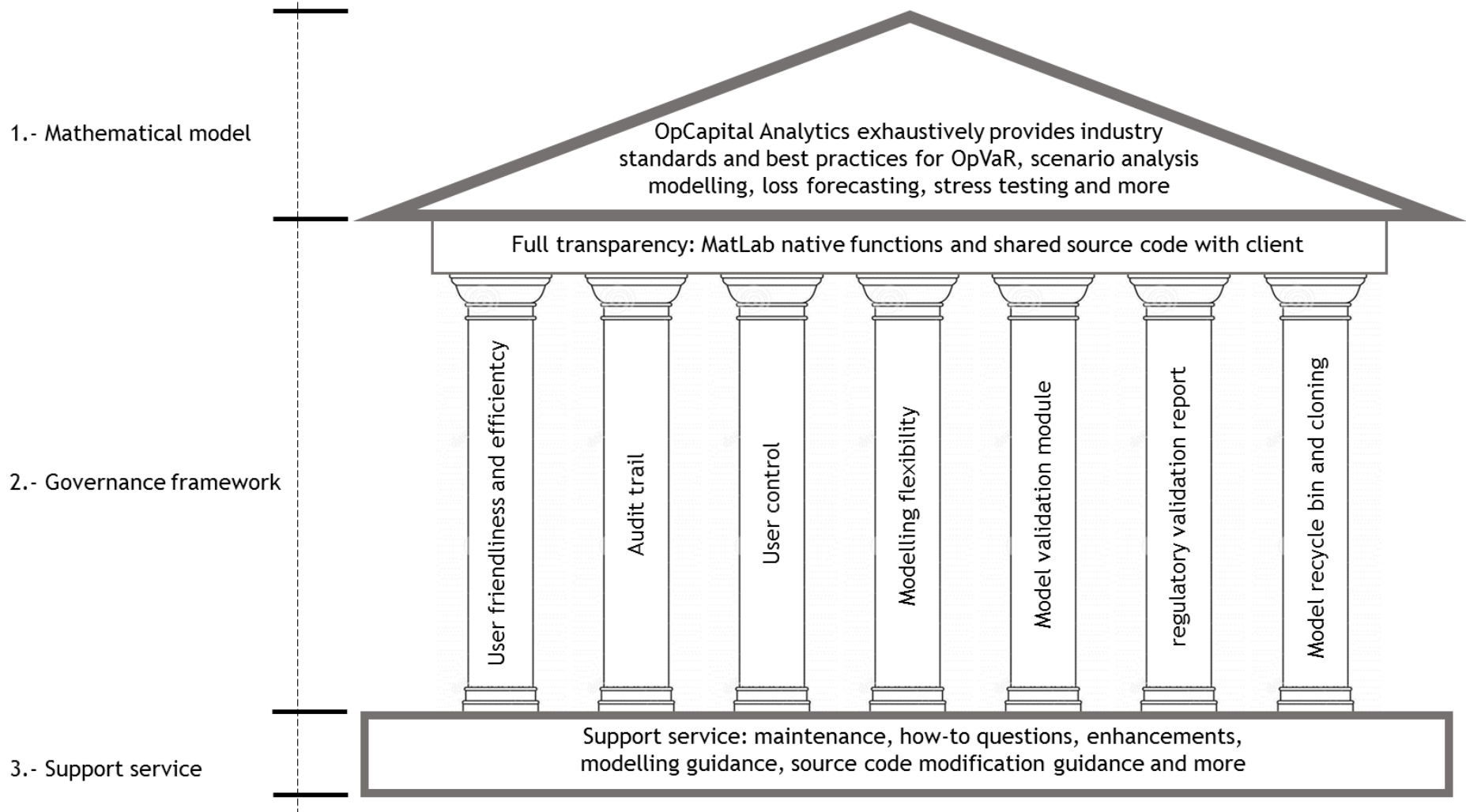
CALCULATED



USING STRUCTURED SCENARIO ANALYSIS FOR AN EFFECTIVE OPERATIONAL RISK MANAGEMENT AND STABLE CAPITAL REQUIREMENTS DETERMINATION

BY RAFAEL CAVESTANY, ETIENNE HOFSTETTER AND DANIEL RODRIGUEZ

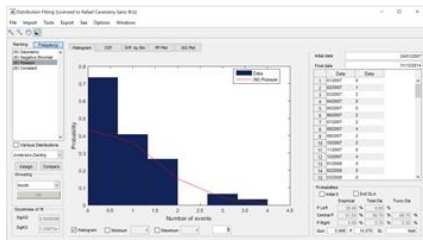
TAB's GRC Analytics contains an extensive mathematical model supported by a strong governance framework and TAB provides robust support service



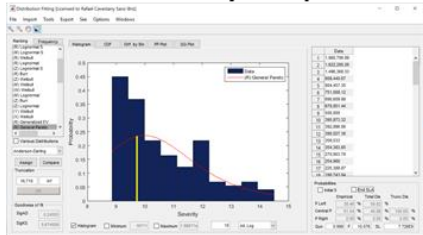
Our GRC Analytics has a model risk governance and validation features: auto-storing all modelling data, audit trail, one-click model replication, reg. reports...

Using our GRCs Analytics model risk governance module can be used for model validation and approval, review of all model assumptions, replication of the model, reporting of the full model, in an extremely efficient manner

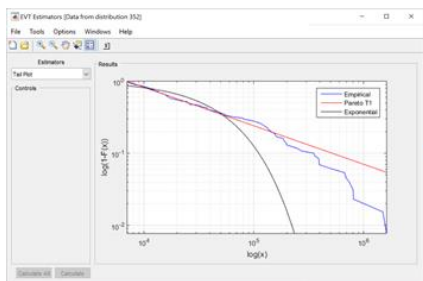
One-click frequency fit replication



One-click severity fit replication



One-click EVT replication

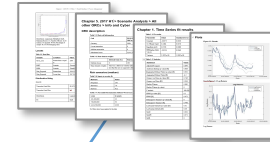


- Model recycle bin
- Model cloning
- Model copying

Risk mitigation conclusions



Regulatory approval reporting



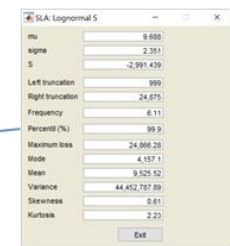
Audit trail

Audit trail (col 23)									
id	idref	User	Operation	Type	Time	Application Module	Data Origin	Operation Data	Operation Details
1	253	Reactor	Insert	Auto	09/11/2015	Insert Data		Assign Call	Col 23
2	Reactor	Insert	Auto	09/11/2015	Insert Data				
3	Reactor	Insert	Auto	09/11/2015	Insert Data				
4	Reactor	Insert	Auto	09/11/2015	Insert Data				
5	Reactor	Insert	Auto	09/11/2015	Insert Data				
6	Reactor	Insert	Auto	09/11/2015	Insert Data				
7	Reactor	Insert	Auto	09/11/2015	Insert Data				
8	Reactor	Insert	Auto	09/11/2015	Insert Data				
9	Reactor	Insert	Auto	09/11/2015	Insert Data				
10	Reactor	Insert	Auto	09/11/2015	Insert Data				
11	Reactor	Insert	Auto	09/11/2015	Insert Data				
12	Reactor	Insert	Auto	09/11/2015	Insert Data				
13	Reactor	Insert	Auto	09/11/2015	Insert Data				
14	Reactor	Insert	Auto	09/11/2015	Insert Data				
15	Reactor	Insert	Auto	09/11/2015	Insert Data				
16	Reactor	Insert	Auto	09/11/2015	Insert Data				
17	Reactor	Insert	Auto	09/11/2015	Insert Data				
18	Reactor	Insert	Auto	09/11/2015	Insert Data				
19	Reactor	Insert	Auto	09/11/2015	Insert Data				
20	Reactor	Insert	Auto	09/11/2015	Insert Data				
21	Reactor	Insert	Auto	09/11/2015	Insert Data				
22	Reactor	Insert	Auto	09/11/2015	Insert Data				
23	Reactor	Insert	Auto	09/11/2015	Insert Data				
24	Reactor	Insert	Auto	09/11/2015	Insert Data				
25	Reactor	Insert	Auto	09/11/2015	Insert Data				
26	Reactor	Insert	Auto	09/11/2015	Insert Data				
27	Reactor	Insert	Auto	09/11/2015	Insert Data				
28	Reactor	Insert	Auto	09/11/2015	Insert Data				
29	Reactor	Insert	Auto	09/11/2015	Insert Data				
30	Reactor	Insert	Auto	09/11/2015	Insert Data				
31	Reactor	Insert	Auto	09/11/2015	Insert Data				
32	Reactor	Insert	Auto	09/11/2015	Insert Data				
33	Reactor	Insert	Auto	09/11/2015	Insert Data				
34	Reactor	Insert	Auto	09/11/2015	Insert Data				
35	Reactor	Insert	Auto	09/11/2015	Insert Data				
36	Reactor	Insert	Auto	09/11/2015	Insert Data				
37	Reactor	Insert	Auto	09/11/2015	Insert Data				
38	Reactor	Insert	Auto	09/11/2015	Insert Data				
39	Reactor	Insert	Auto	09/11/2015	Insert Data				
40	Reactor	Insert	Auto	09/11/2015	Insert Data				
41	Reactor	Insert	Auto	09/11/2015	Insert Data				
42	Reactor	Insert	Auto	09/11/2015	Insert Data				
43	Reactor	Insert	Auto	09/11/2015	Insert Data				
44	Reactor	Insert	Auto	09/11/2015	Insert Data				
45	Reactor	Insert	Auto	09/11/2015	Insert Data				
46	Reactor	Insert	Auto	09/11/2015	Insert Data				
47	Reactor	Insert	Auto	09/11/2015	Insert Data				
48	Reactor	Insert	Auto	09/11/2015	Insert Data				
49	Reactor	Insert	Auto	09/11/2015	Insert Data				

Modelling journal



Sensitivity analysis

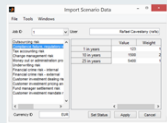


Our GRC Analytics solution provides integrated specific modules for each of the critical blocks for the risk capital, stress testing and AI models

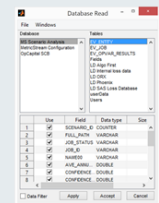
Including Basel Capital's AMA & Pillar 2

Op data import

Import scenarios



Import internal and external loss data

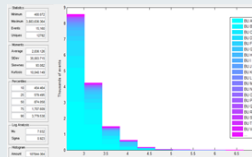


Import KRI, KPI...

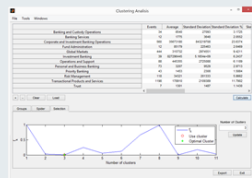


UoM definition

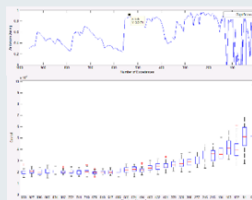
Exploratory analysis and loss data selection



Optimal granularity

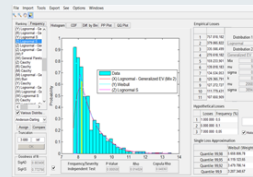


Extreme Value Theory Analysis

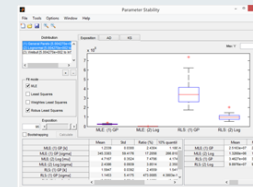


Risk capital modelling

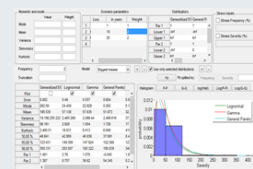
Loss data modelling



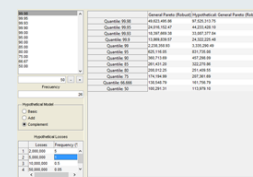
Capital instability analysis



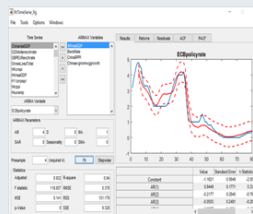
Scenario analysis modelling



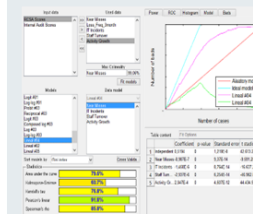
What-if analysis



Stress testing

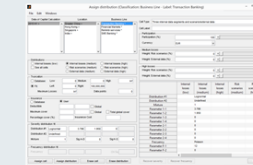


AI prediction models

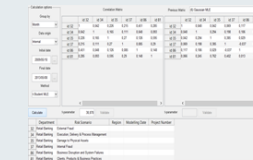


OpVaR and capital

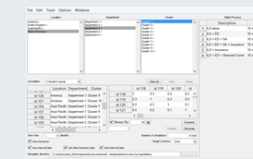
Hybrid model construction



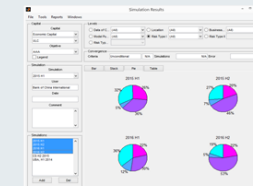
Correlation analysis



Monte Carlo simulation

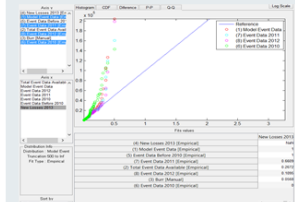


Capital estimates analysis

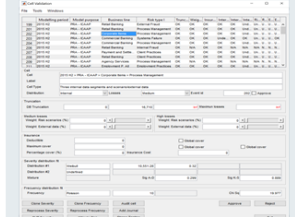


Model validation

Backtesting



Modelling archive and results replication



Validation reports



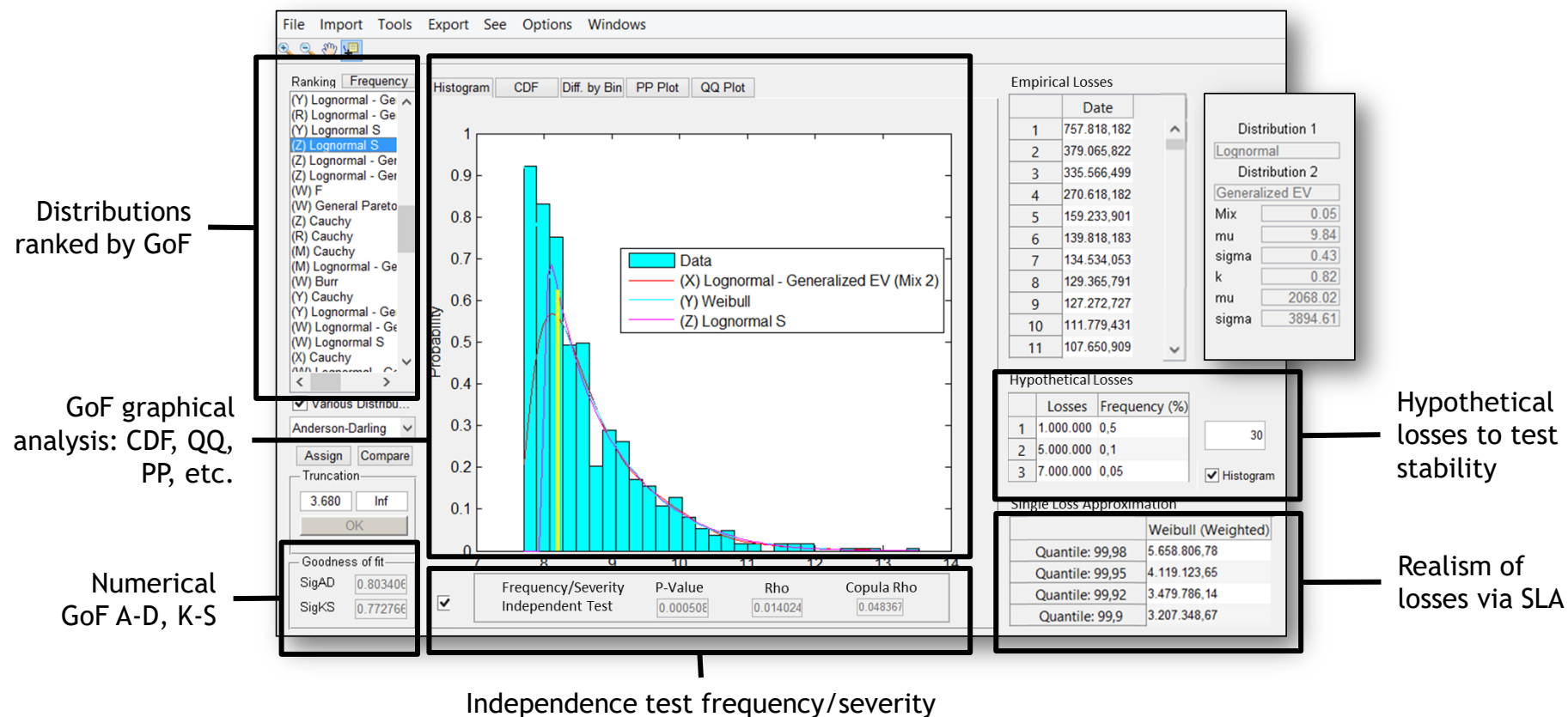
Audit trail, user control, integrated data flows, workflow management, reporting and model archive and replication

ANNEX A: GRC Analytics

Internal and external loss data modelling can be performed in great detailed and precision

Our GRC Analytics provides multiple features for a robust modelling of loss data that includes distribution fitting, Extreme Value Analysis, graphical and numerical goodness of fit analysis, stress testing, instability analysis and more.

Distribution fitting module (severity and frequency)



For loss modelling, TAB provides extensive functionalities permitting the precise determination of modelling thresholds and tail type

The system provides up to 8 methods to estimate Extreme Value Theory and determine tail weight and identify an optimal threshold permitting to separate the distribution in tail and body

EVT methods for determining tail weight and modelling threshold

Lognormal Fit Analysis

Fits a LogNormal distribution and plots Mu and Sigma.

Stability Parameter

Fits Pareto distribution and plots tail parameter.

Tail Plot

Plots Log (Severity) versus Log(1-F(Severity)).

Mean Excess Plot

Plots the mean excess of each sample

Hill Estimator

Plots tail parameter calculated analytically

Hill Estimator Extension

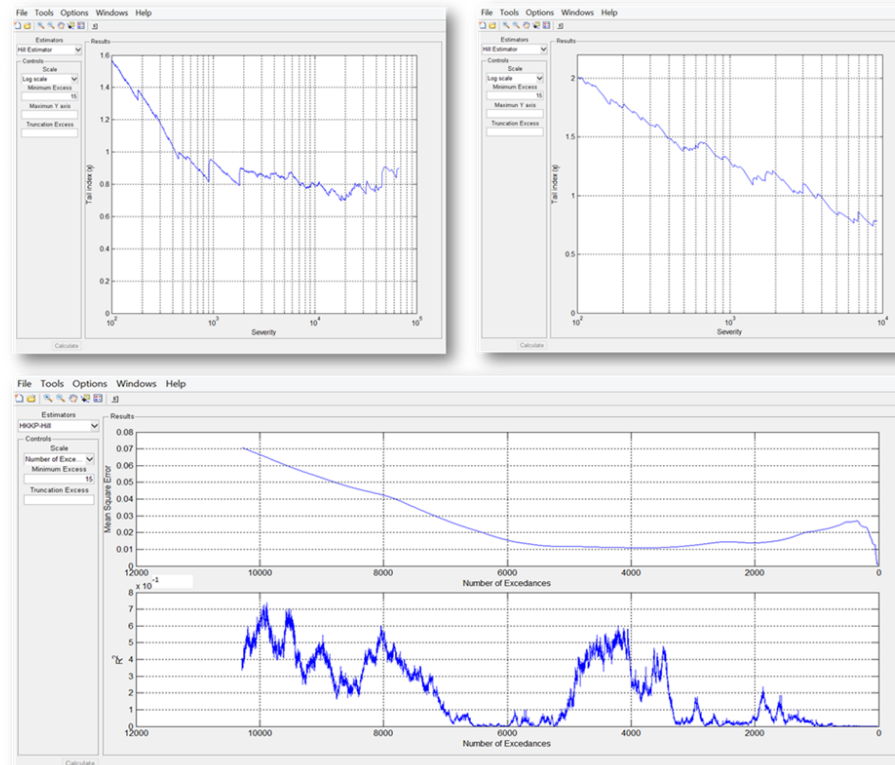
Fits a horizontal line to the Hill Estimator plot to identify the point most similar to a constant tail parameter and, therefore, fat tail.

Capital Stability by Threshold Plot

Randomly resamples an x% of the Sub-sample y times. Fits the selected distribution to random subsample with the selected fitting method and plots capital charge calculated using analytical methods.

GoF by Threshold Plot

Fits selected distribution and plots P-Value of AD and KS.



Fat tail distributions available for EVT

Heavy Tail

- | | |
|---|---|
| <input type="checkbox"/> Burr | <input type="checkbox"/> Generalized EV |
| <input type="checkbox"/> Cauchy | <input checked="" type="checkbox"/> Log Gamma |
| <input type="checkbox"/> F | <input type="checkbox"/> Log Logistic |
| <input checked="" type="checkbox"/> GPD | <input type="checkbox"/> Pareto |
| <input checked="" type="checkbox"/> GPD S | <input type="checkbox"/> Student's T |

TAB provides extensive options for the modelling of scenario analysis and corresponding mitigation and any other expert elicited risk evaluation

The screenshot shows the 'Fit Moments and Quantiles' window with the following annotated components:

- Introduce distribution shape control statistics:** Points to the 'Moments and Quantiles' section on the left.
- Introduce scenario frequency:** Points to the 'Frequency' input field.
- Fitting truncation:** Points to the 'Truncation' input field.
- Fitting error by distribution:** Points to the 'Plot Error' checkbox.
- Loss estimates and moments of the fitted distributions:** Points to the table of statistical moments.
- Parameters of fitted distributions:** Points to the table of distribution parameters.
- SLA values:** Points to the 'Stress' button.
- Assign the scenario distribution model to ORC:** Points to the 'Assign' button.
- Buttons that permit to select the distributions to be considered in the fit:** Points to the 'Generalized EV' button.
- Weight for prioritizing fitting target:** Points to the 'Weight' column in the 'Scenario parameters' table.
- Introduce the scenario analysis results for their modelling:** Points to the 'Scenario parameters' table.
- Weight for prioritizing fitting target:** Points to the 'Weight' column in the 'Generalized EV' table.
- Permits to introduce distribution parameters restrictions into the fit:** Points to the 'Stress inputs' section.
- Permits to introduce the impact of simulate impact of control effectiveness/scores. Alternatively, it permits to stress oprisk:** Points to the 'Stress Frequency (%)' and 'Stress Severity (%)' checkboxes.
- Split scenario based on frequency or severity:** Points to the 'Fit split by:' dropdown menu.
- Selection of GoF graphical analysis:** Points to the 'Histogram', 'P-P', 'Q-Q', 'log(Hist)', 'Log(P-P)', and 'Log(Q-Q)' buttons.
- Graphical goodness of fit:** Points to the histogram plot showing 'probability' vs 'Severity'.

	Loss	in years	Weight
1	100	1	1
2	325	10	2
3	600	25	2

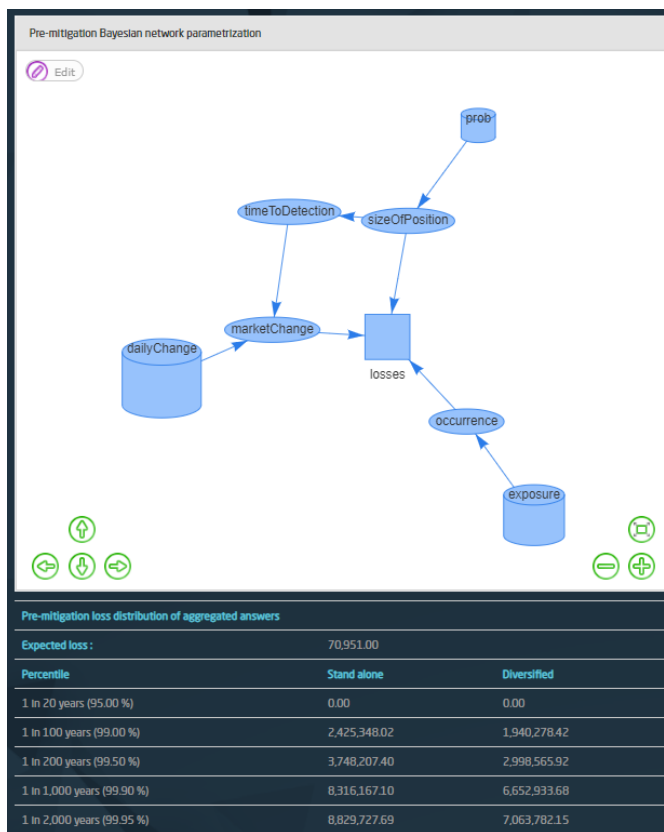
	Generalized EV	General Pa
Par 1	1	0.3
Lower	-Inf	0.2
Upper	Inf	0.3
Par 2	1	1
Lower	-Inf	0
Upper	Inf	Inf

	Generalized EV	Lognormal	General Pareto	Weibull	Gamma
MODE	17.503	24.405	2.025	1.030	0.511
Mean	127.747	98.414	92.661	93.022	93.118
Variance	87,654.618	14,180.902	14,887.52	12,958.699	12,777.486
Skewness	27.996	4.362	4.036	2.602	2.360
Kurtosis	1,084.327	36.373	32.067	13.005	10.877
66.67 %	100	93.81	89.622	93.702	95.622
96.67 %	325	364.296	368.757	372.944	373.211
99.67 %	600	527.287	527.477	499.199	490.177
Par 1	0.77	4.125	0.228	83.527	0.670
Par 2	15.001	0.967	71.798	0.818	138.89
Par 3	80.439				

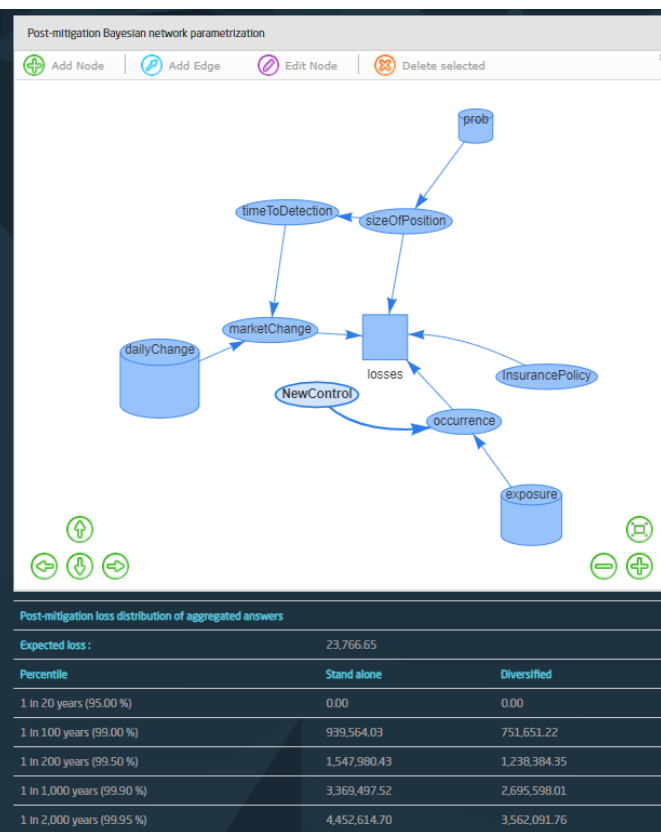
SSA permits to model scenarios using a variety of methods including Bayesian networks for those scenarios most sensitive to current exposures or in which detailed analysis is needed for a precise estimation of losses or mitigation impact

A complete and efficient modelling of scenario analysis requires the combination of modelling methods. Bayesian networks may be used in exposure sensitive scenarios or requiring a precise loss estimation or mitigation NPV. Less critical scenarios might be modelled using direct and less resource intensive methods such as direct estimation of losses (worst loss in 10 years...)

Pre-mitigation analysis

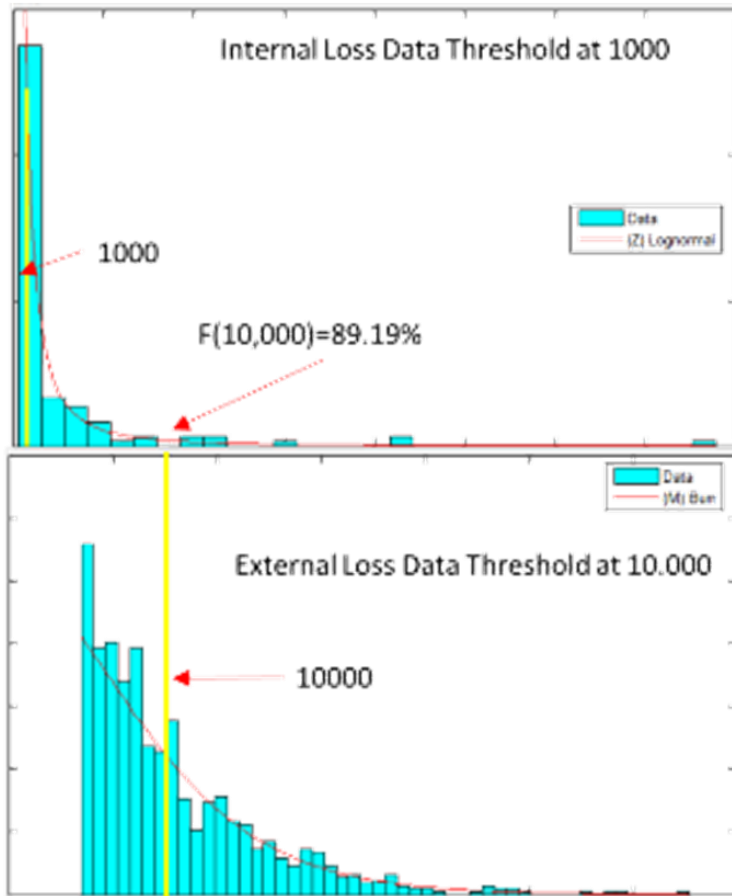


Post-mitigation analysis



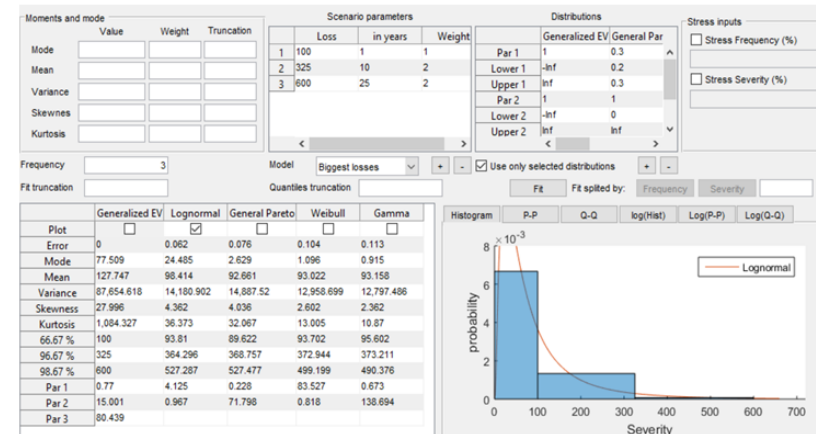
Internal & external loss data and scenario analysis create hybrid models incorporating all available information for risk measurement and management

Internal loss data modelling



External loss data modelling

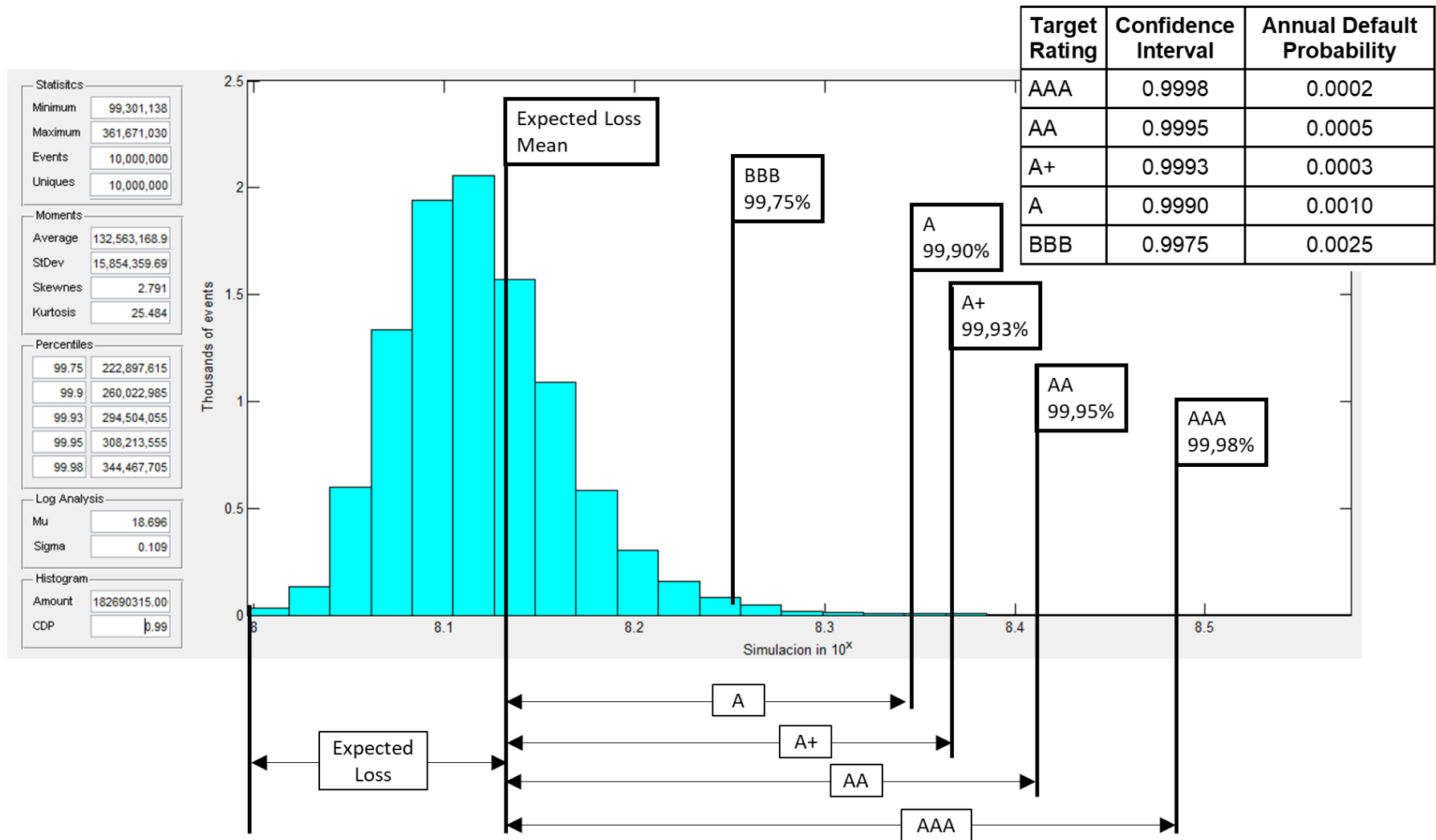
Scenario analysis modelling



	Internal losses (low)	Internal losses (medium)	Internal losses (high)	Risk scenarios (medium)	Risk scenarios (high)	External data (medium)	External data (high)
Distribution #1	Empirical	Lognormal	Burr	Lognormal	Lognormal	Lognormal	Lognormal
Distribution #2	Undefined	Undefined	Undefined	Undefined	Undefined	Undefined	Undefined
Mixture	1	1	1	1	1	1	1
Parameter 1-1	0	7.971	0.007	7.971	17.158	7.971	7.971
Parameter 1-2	0	2.072	1.311,896	2.072	0.533	2.072	2.072
Parameter 1-3	0	0	1.371	0	0	0	0
Parameter 1-4	0	0	0	0	0	0	0
Parameter 2-1	0	0	0	0	0	0	0
Parameter 2-2	0	0	0	0	0	0	0
Parameter 2-3	0	0	0	0	0	0	0
Parameter 2-4	0	0	0	0	0	0	0
Frequency	Poisson	Poisson	Poisson	Poisson	Poisson	Poisson	Poisson
Parameter F-1	5.858	50.1	4.642	0.1	4.642	4.642	4.642
Parameter F-2	0	0	0	0	0	0	0

Hybrid model

Our GRC Analytics includes VaR calculation under a user defined confidence levels and any other metrics: expected shortfall, unexpected loss and others



Our GRC Analytics are flexible and can be applied across other GRC Risk categories such as BrandRisk and obtain Brand VaR or IT Risk



TAB provides extensive functionalities for the determination of correlations based on loss data permitting easy comparison, selection and storage

Place selected distribution on the left grid for applying it into Monte Carlo

Last calculated correlation and correlation matrix to be applied in the Monte Carlo run

Other previously calculated correlation

Selection of previously calculated correlation

Time grouping for correlation calculation

Data element to be used in the calculation of correl

Initial and final date of loss data observation period

Calculation method: Kendal Tau, Spearman Ro, multivariant Gsussian copula and t-Student copula

Launch correl calculation

ORCs selected for the Monte Carlo simulation

Validate: if activated, the correl is not PSD and by clicking, the correl gets transformed into PSD

Set the selected correlation matrix into the Monte Carlo window

The interface displays two correlation matrices side-by-side. The 'Correlation Matrix' on the left shows correlations for six data points (id 32, 34, 35, 37, 86, 81). The 'Previous Matrix' on the right shows correlations for the same six data points, with a dropdown menu set to '(1) Original Data'. Below the matrices are 'Calculate' and 'Validate' buttons. At the bottom is a table of ORCs (Operational Risk Categories) with columns for Department, Risk Scenario, Region, Modelling Date, and Project Number. The table lists six ORCs related to Retail Banking. At the bottom right are 'Apply' and 'Cancel' buttons.

	id 32	id 34	id 35	id 37	id 86	id 81
id 32	1	0.202	-0.038	0.136	0.118	0.002
id 34	0.202	1	0.477	0.3	0.037	0.342
id 35	-0.038	0.477	1	0.398	-0.054	0.958
id 37	0.136	0.3	0.398	1	0.117	0.354
id 86	0.118	0.037	-0.054	0.117	1	-0.138
id 81	0.002	0.342	0.958	0.354	-0.138	1

	id 32	id 34	id 35	id 37	id 86	id 81
id 32	1	0.05	-0.009	0.033	0.028	0.001
id 34	0.05	1	0.469	0.31	0.021	0.35
id 35	-0.009	0.469	1	0.382	-0.043	0.946
id 37	0.033	0.31	0.382	1	0.099	0.324
id 86	0.028	0.021	-0.043	0.099	1	-0.136
id 81	0.001	0.35	0.946	0.324	-0.136	1

	Department	Risk Scenario	Region	Modelling Date	Project Number
32	Retail Banking	External Fraud			
34	Retail Banking	Execution, Delivery & Process Management			
35	Retail Banking	Damage to Physical Assets			
37	Retail Banking	Internal Fraud			
86	Retail Banking	Business Disruption and System Failures			
81	Retail Banking	Clients, Products & Business Practices			

When enough relevant loss data is not available for correlation calculation, our GRC Analytics permits the determination of correlations through expert elicitation

- Experts provide their estimate on the influence of the different environment factors that impact crystallisation of risks. These estimates are later weighted by the seed questions performance score obtained by each expert
- The final risk scenarios correlation matrix is calculated with the correlations across the environment factors and the weight of each factor in the risk scenario

Dependency factors

Employees and vendors	<input type="text" value="20"/> %	The quality and ability of the institution's employees, vendors and other resources;
Business complexity	<input type="text" value="0"/> %	The complexity and riskiness of the business, products and processes they use to deliver them;
Degree of automation	<input type="text" value="20"/> %	The degree of automation of the product processes and capacity of the institution for automation;
Legal environment	<input type="text" value="0"/> %	The legal and regulatory environment of the business;
Market evolution	<input type="text" value="10"/> %	The evolution of the institution markets, including the diversity and sophistication of its customers and counterparties, the liquidity of the capital markets it trades in and the reliability of the infrastructure which supports those markets.
Idiosyncratic	<input type="text" value="50"/> %	A structural or behavioral characteristic peculiar only to this scenario with no correlation with the other scenarios.

Risk factor name

Definition of risk factor to guide SMEs

SMEs provide their estimates on the influence of the risk drivers in the scenario

TAB provides methods for determining risk dependencies using expert elicitation methods, being fully integrated into the tool's calculations

Sensitivity to common environment factors is used to determine correlations. A high correlation can be tracked to sensitivities to the same environment factors. Independent scenarios derive from sensitivity to different environment factors

Experts estimates on the influence of risk drivers into the risks scenarios

Qualitative Correlations

File Edit Windows

UoM

3PV
Major system failure
Data management
Info and cyber security
Reg non compliance
Internal fraud
Market misconduct
Product management

Factor Sensitivity
Business complexity
Employees and work environment
Fraud environment
Internal control environment
Regulatory and legal
Technology environment
Vendors and externals

Sensitivity Result

	Business complexity	Employees and work environment	Fraud environment	Internal control environment	Regulatory and legal	Technology environment
3PV	0,1	0	0	0,2	0	0,1
Major system failure	0	0,1	0	0,1	0	0,3
Data management	0	0,1	0,1	0,1	0	0,3
Info and cyber security	0	0	0,3	0,2	0	0,2
Reg non compliance	0,2	0,1	0	0,2	0,2	0
Internal fraud	0	0,2	0,2	0,2	0,2	0
Market misconduct	0	0,2	0,2	0,2	0	0
Product management	0,2	0,2	0	0	0	0
AML	0	0,2	0,2	0,2	0,2	0
Sanction	0	0,2	0,2	0,2	0,2	0
External fraud	0	0	0,4	0,2	0	0,2
Anti bribery and corruption	0	0,2	0,2	0,2	0	0

Export Exit

Qualitative Correlations

File Edit Windows

UoM

3PV
Major system failure
Data management
Info and cyber security
Reg non compliance
Internal fraud
Market misconduct
Product management

Factor Sensitivity
Business complexity
Employees and work environment
Fraud environment
Internal control environment
Regulatory and legal
Technology environment
Vendors and externals

Sensitivity Result

	3PV	Major system failure	Data management	Info and cyber security	Reg non compliance	Internal fraud	Market misconduct	Product management
3PV	1,00	,57	,38	,23	,28	,18	,18	,09
Major system failure	,57	1,00	,62	,35	,16	,20	,20	,10
Data management	,38	,62	1,00	,46	,15	,29	,29	,10
Info and cyber security	,23	,35	,46	1,00	,18	,44	,44	,00
Reg non compliance	,28	,16	,15	,18	1,00	,53	,42	,42
Internal fraud	,18	,20	,29	,44	,53	1,00	,60	,20
Market misconduct	,18	,20	,29	,44	,42	,60	1,00	,40
Product management	,09	,10	,10	,00	,42	,20	,40	1,00
AML	,18	,20	,29	,44	,53	,80	,60	,20
Sanction	,18	,20	,29	,44	,53	,80	,60	,20
External fraud	,22	,34	,48	,74	,18	,51	,51	,00
Anti bribery and corruption	,15	,17	,24	,37	,27	,51	,51	,17

Minimum correlation

Export Exit

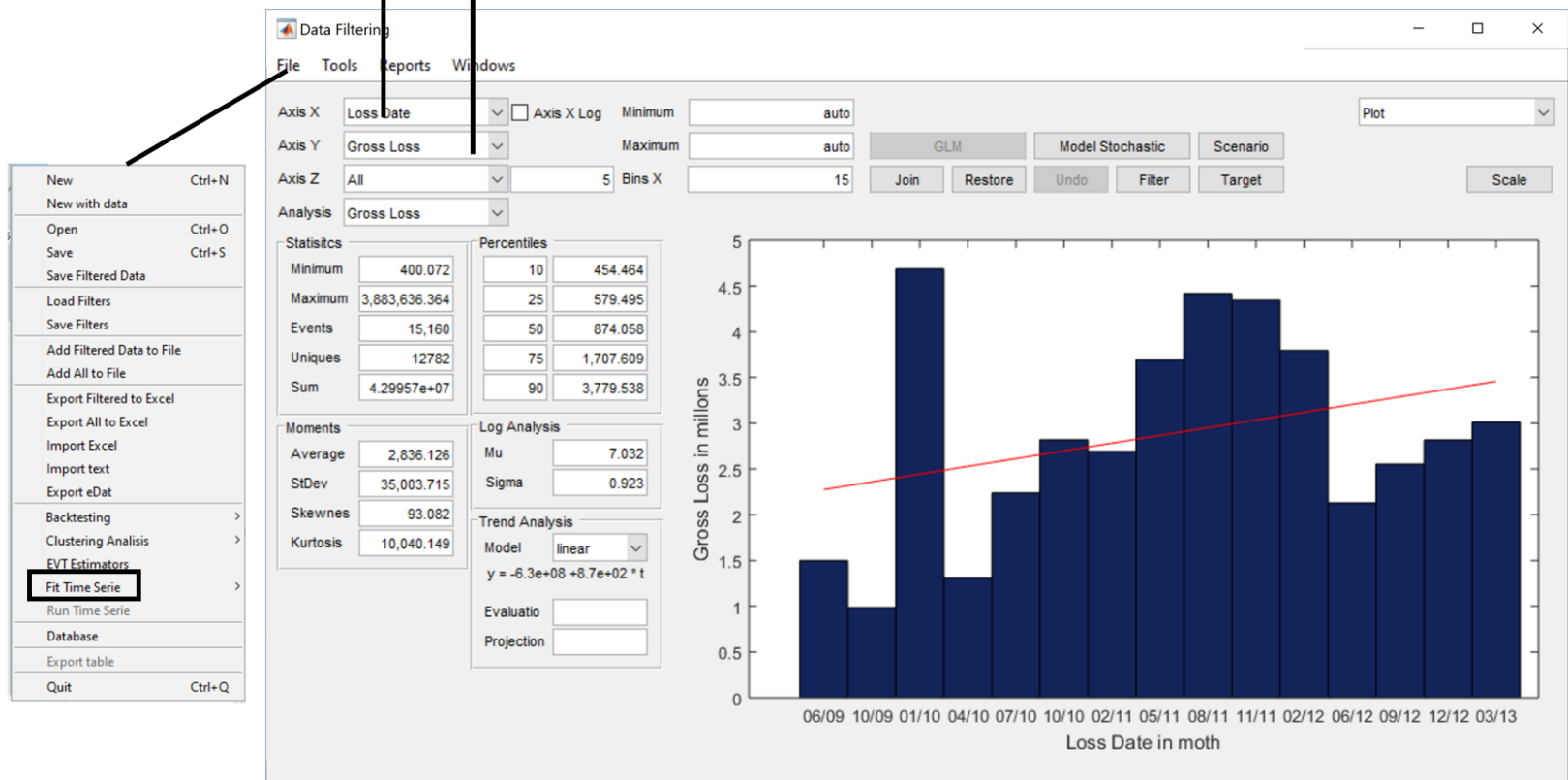
Resulting correlations from the sensitivity of risk drivers

TAB creates directly from the OpRisk database, loss time series for stress testing purposes: time series of total losses, frequencies, tail values or any other metric

Our GRC Analytics automates the creation of times series of los data creating a seamless link with stress testing analysis of macroeconomic variables or other indicators such as KCI, KPI, KRI...

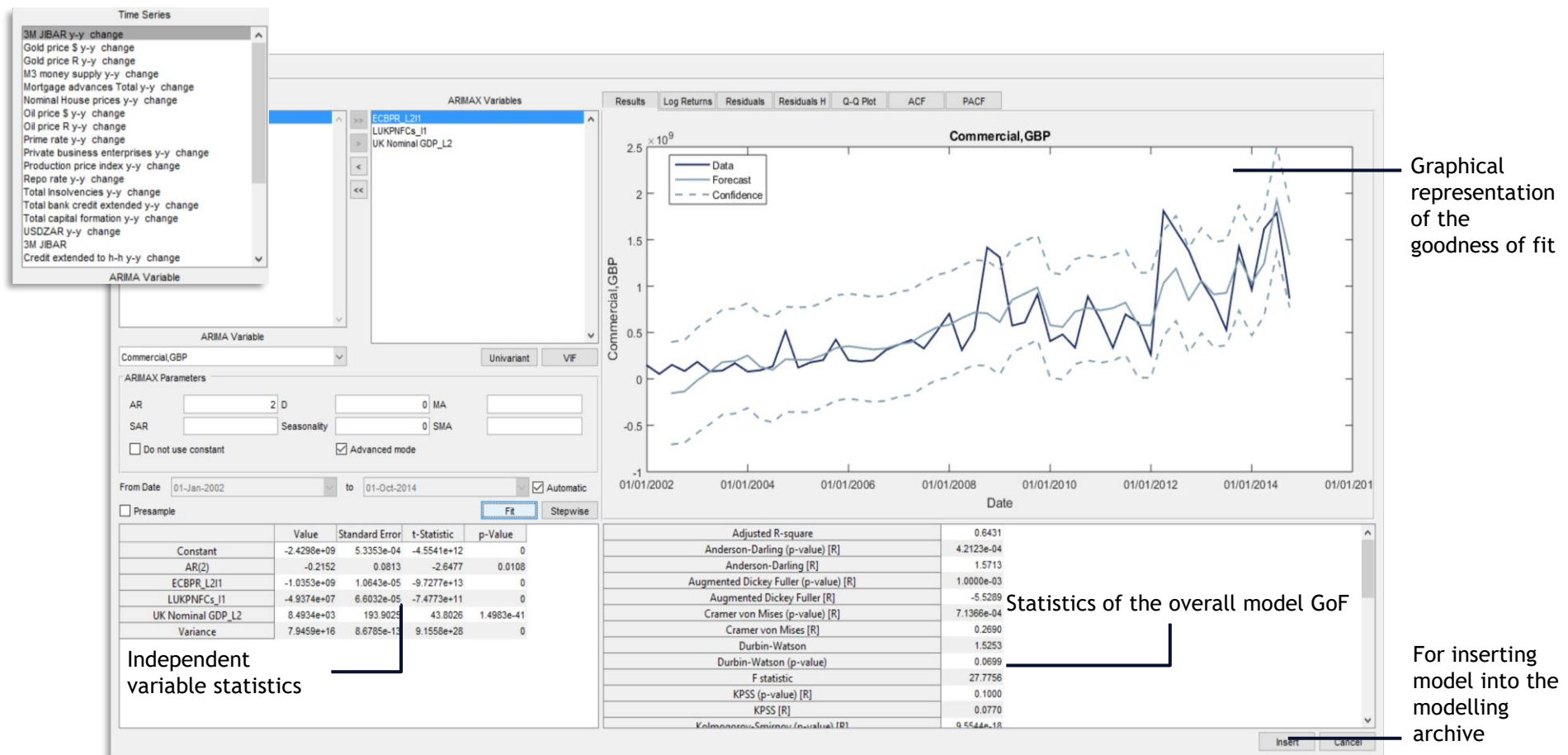
Date field required in Axis X Select a loss amount field or "Events", in Axis Y

Click to send data to
the forecasting
model module and to
create the loss time
serie



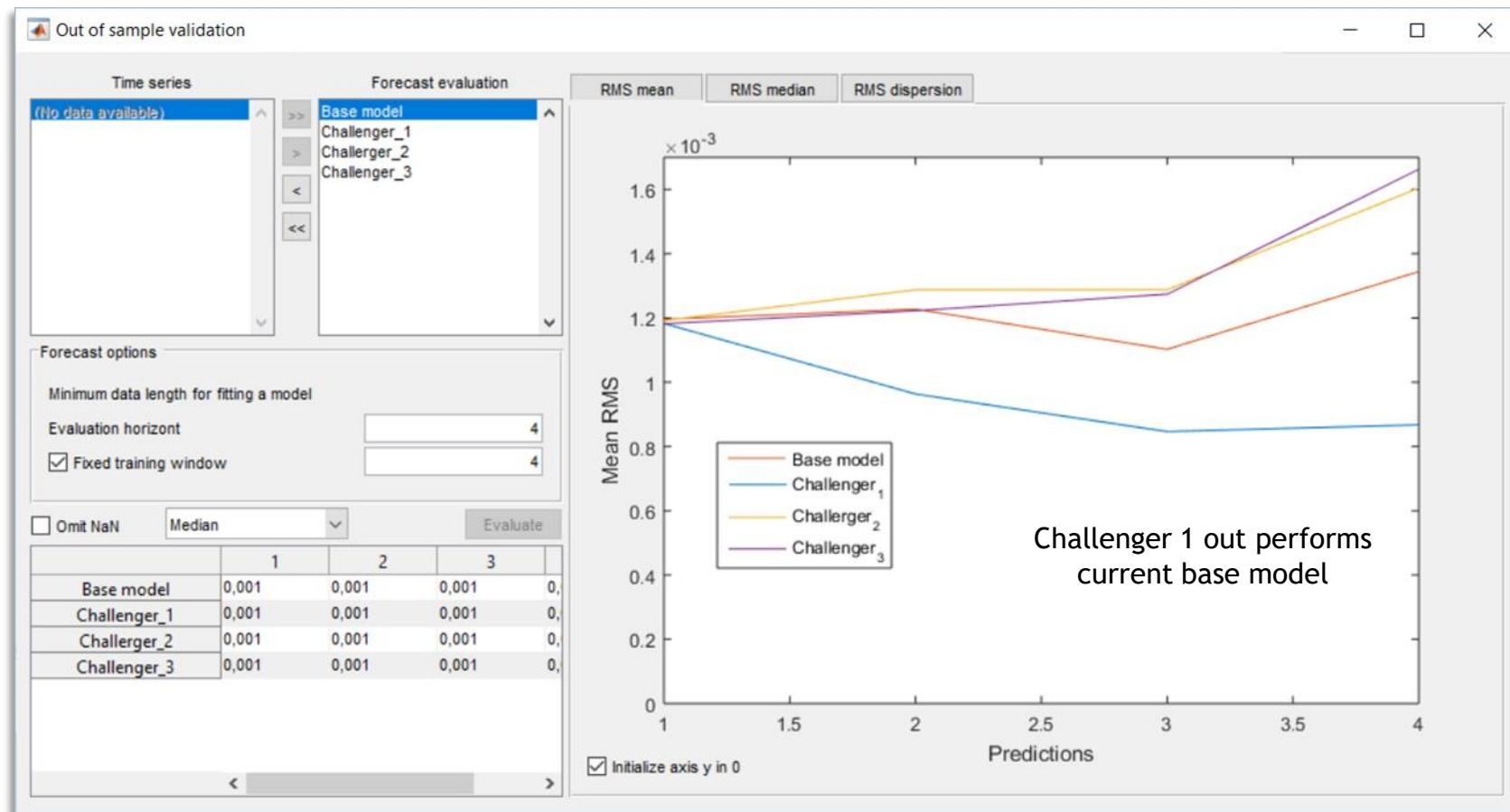
Loss times series are regressed against macroeconomic factors, KRIs, KCIs and other metrics to create loss forecasting macroeconomic models

The models created provide the loss expectation under any type of scenario: base case, stress scenario, severely adverse... permitting its integration into the global stress testing exercise



TAB's GRC Analytics supports a champion multi-challenger approach for identifying forecasting model performing most robust predictions

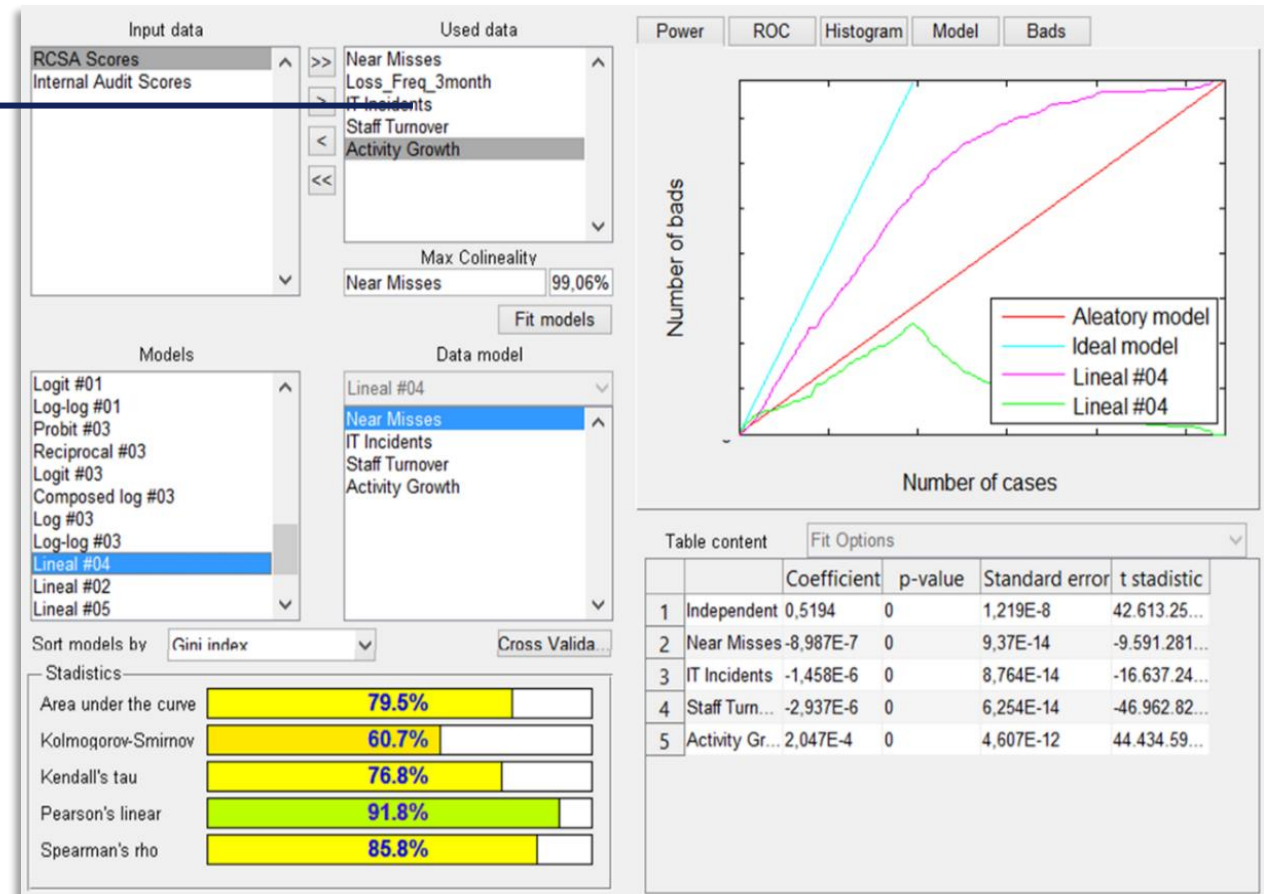
Our solutions provide extensive out-of-sample model validation to confirm the true causality found in the risk factors allowing for a robust and credible projection



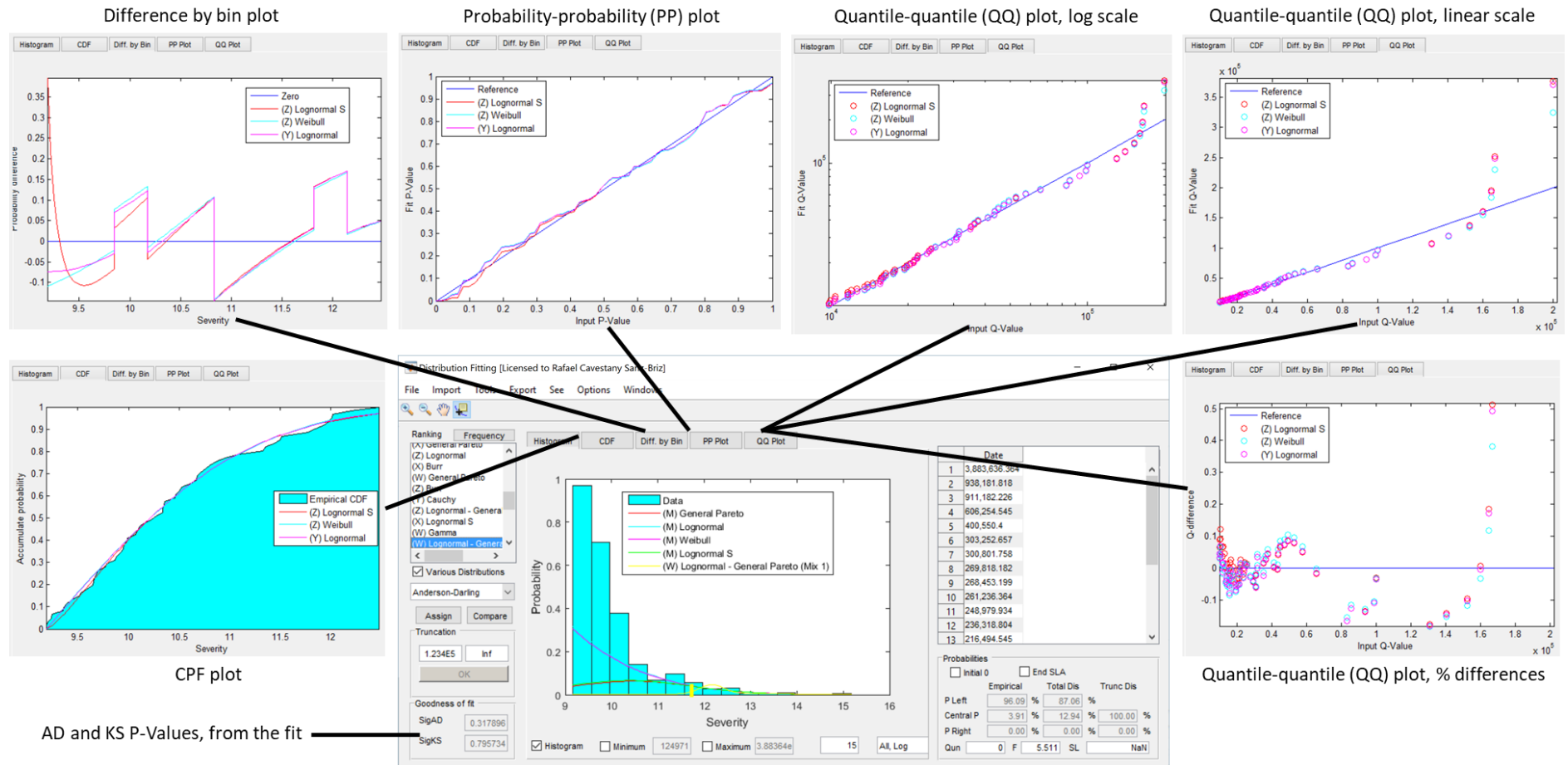
TAB provide Machine Learning techniques to predict large losses as different risk indicators change, such as staff turnover IT incidents and other

Using machine learning the user may develop models to identify those business units, processes, risk types where is more likely to experience a deterioration of the control environment

Different risk indicators are automatically modelled to select most predictive combination of variables



Special focus is given to scientific validation of Analytics both for those data based models as well as expert elicited models



Expert judgment requires solid validation and our GRC Analytics use Structured Expert Judgment to validate the quality of the expert based risk evaluations

Seed questions are embedded into the questionnaire to assess the SMEs' skills in evaluating risk events and to weight SME answers accordingly. Seed questions are questions whose answers are known. The performance of experts in seed questions is used to evaluate the skills/knowledge of experts in predicting uncertain events calculating a performance score per participating expert. Such score is used to aggregate the individual answers into an aggregated answer per risk scenario

Definition of seed questions into the scenario questionnaire

The screenshot displays the 'Loss estimates' tab of a scenario questionnaire. It features three main sections: 'Distribution shape estimates', 'Worst losses', and 'Frequency of losses'. Red boxes and arrows highlight the 'Seed' question definition process across these sections.

- Distribution shape estimates:** A 'Seed' input field is highlighted with a red box.
- Worst losses:** This section includes a dropdown menu set to 'Worst losses', checkboxes for 'Minimum loss' and 'Maximum loss', a 'Worst loss in: [] years' field, and a 'Text for seed question:' field. Two 'Seed' input fields with 'Add' buttons are highlighted with red boxes. Red arrows point from the 'Seed' field in the 'Distribution shape estimates' section to the first 'Seed' field here, and from the 'Text for seed question:' field to the second 'Seed' field.
- Frequency of losses:** An 'Annual frequency:' field with a checked checkbox and a 'Seed' input field with an 'Add' button is highlighted with a red box. A red arrow points from the 'Seed' field in the 'Worst losses' section to this 'Seed' field.

The SMEs’ answers are aggregated based on their seed questions performance and the aggregated answer is used for the modelling

SME answers are aggregated based on seed questions performance

The weight from the seed question performance can be overridden

Weight assignation to experts

Participant	Expert performance score	Score override	Expert answer weight	Override justification
peter.mills	0.846	<input type="text" value="1"/>	0.6666666666666666	<input type="text"/>
john.smith	0.134	<input type="text" value="0"/>	0.3333333333333333	<input type="text"/>

Calculate

Save

Aggregated pre-mitigation loss estimates

In years	Losses	Overwrite
2	100.00	<input type="text" value="100"/>
5	200.00	<input type="text" value="200"/>
7	400.00	<input type="text" value="400"/>
25	600.00	<input type="text" value="600"/>
Annual frequency	5.00	<input type="text" value="5"/>

Rational for overwrite

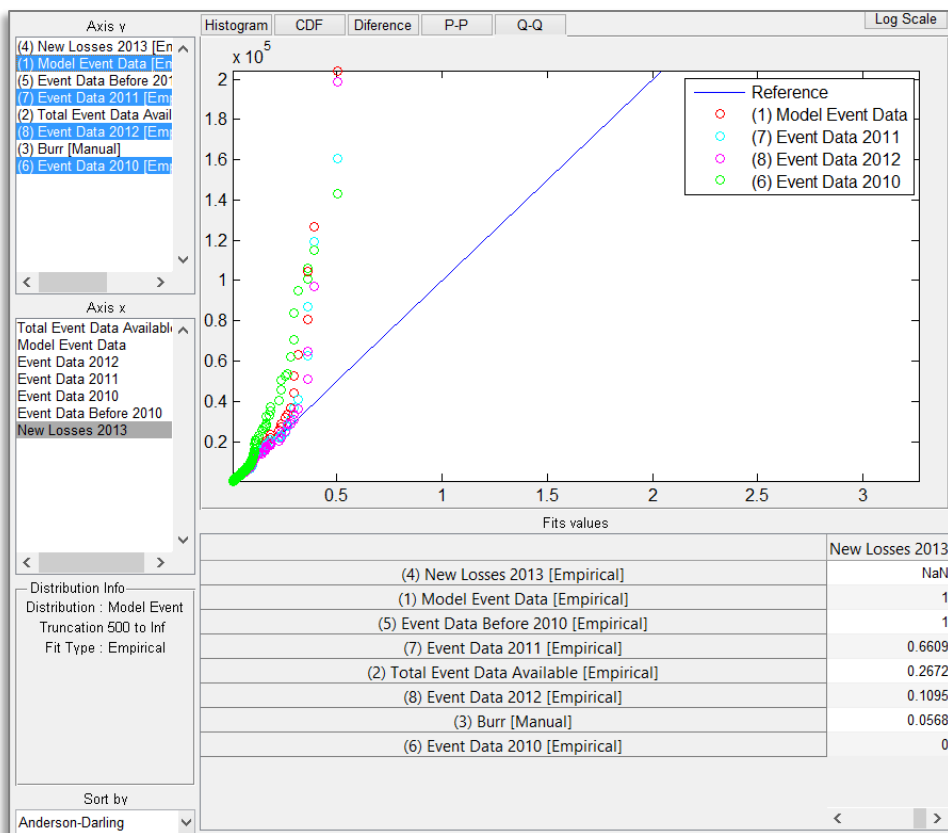
Aggregated post-mitigation loss estimates

In years	Losses	Overwrite
2	50.00	<input type="text" value="50"/>
5	150.00	<input type="text" value="150"/>
7	200.00	<input type="text" value="200"/>
25	500.00	<input type="text" value="500"/>
Annual frequency	2.00	<input type="text" value="2"/>

Rational for overwrite

Validation and backtesting

Finally, our solution provides the means to perform validation and backtesting on scenario analysis. The analysis can be done ex-ante, by validating the expert risk assessments against internal or external losses before the capital calculation. It can also be done ex-post, and backtest the capital against the losses materialized in the subsequent periods after the capital requirements calculations.



Backtesting of severity:

- Distribution used to calculate capital compared to new losses
- New losses compared to the losses used to construct the capital model

Backtesting of frequencies:

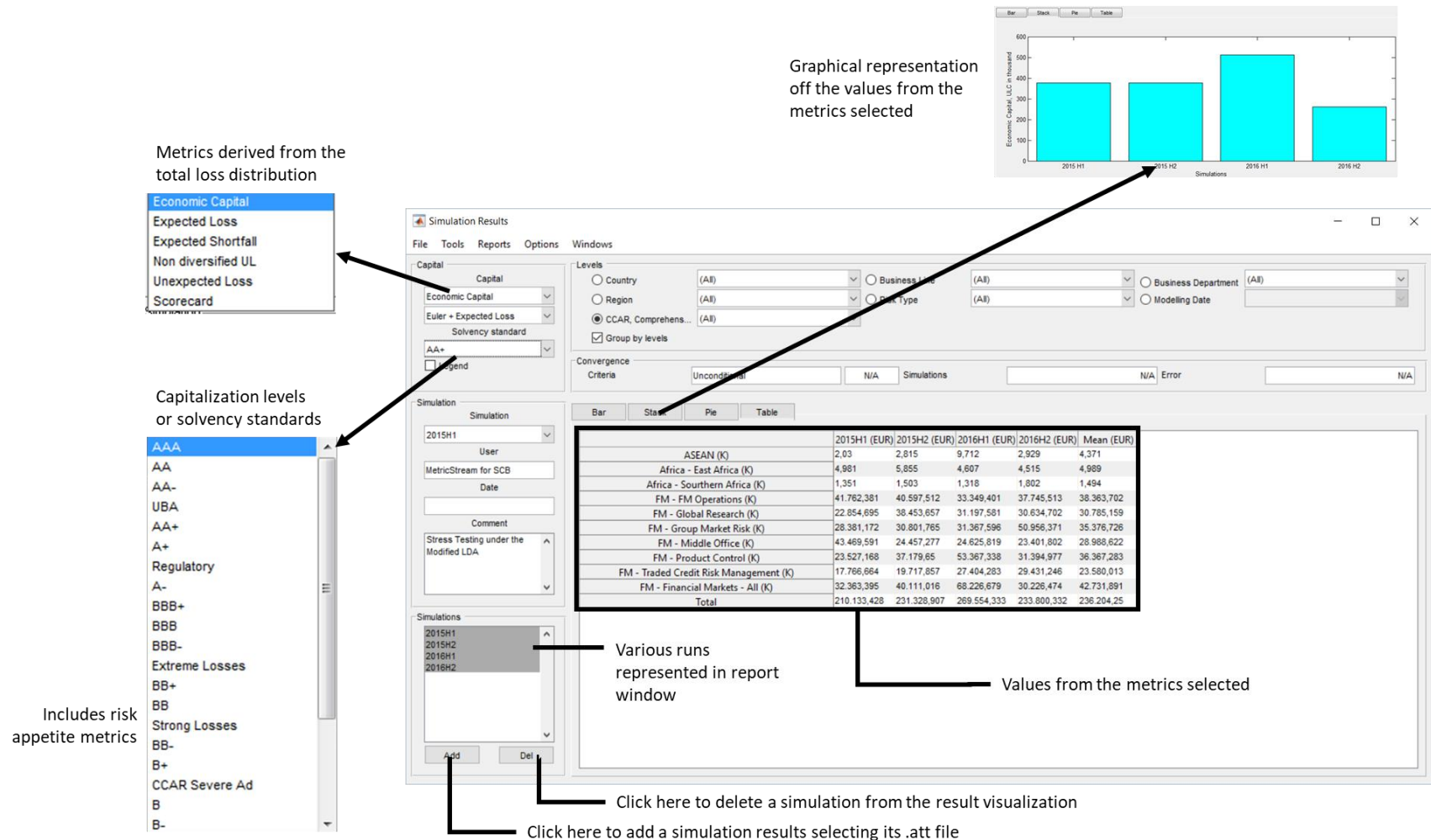
- Violation ratio using UoMs observations

Backtesting of total losses:

- Violation ratio using UoMs observations

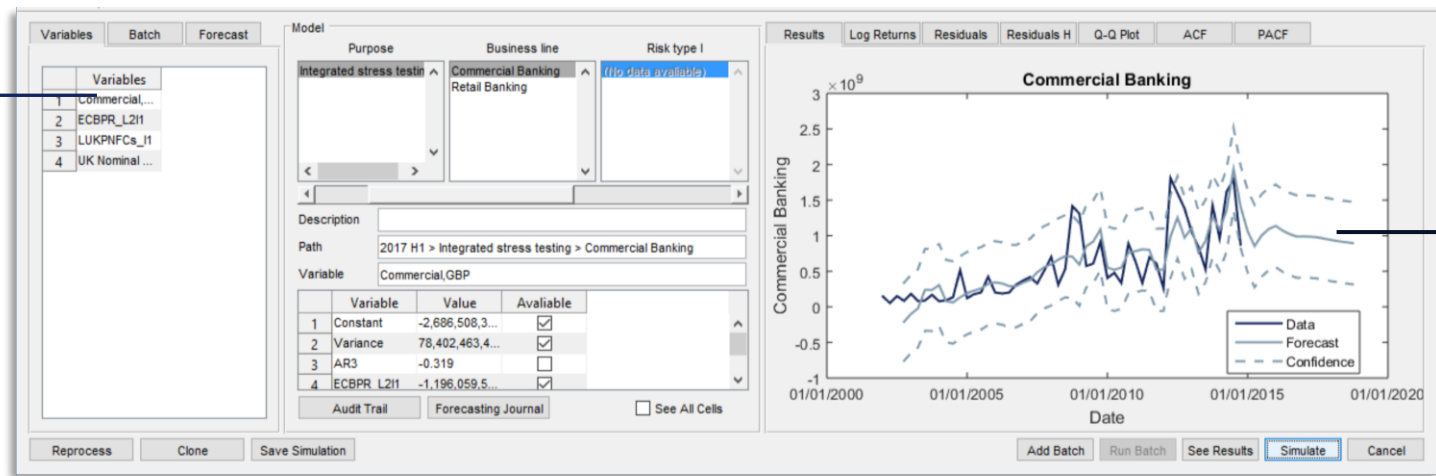
ANNEX B: Risk “monetary value based” management

TAB provides extensive analysis of capital requirements (Basel, Solvency...) and risk appetite metrics under user defined number of confidence levels

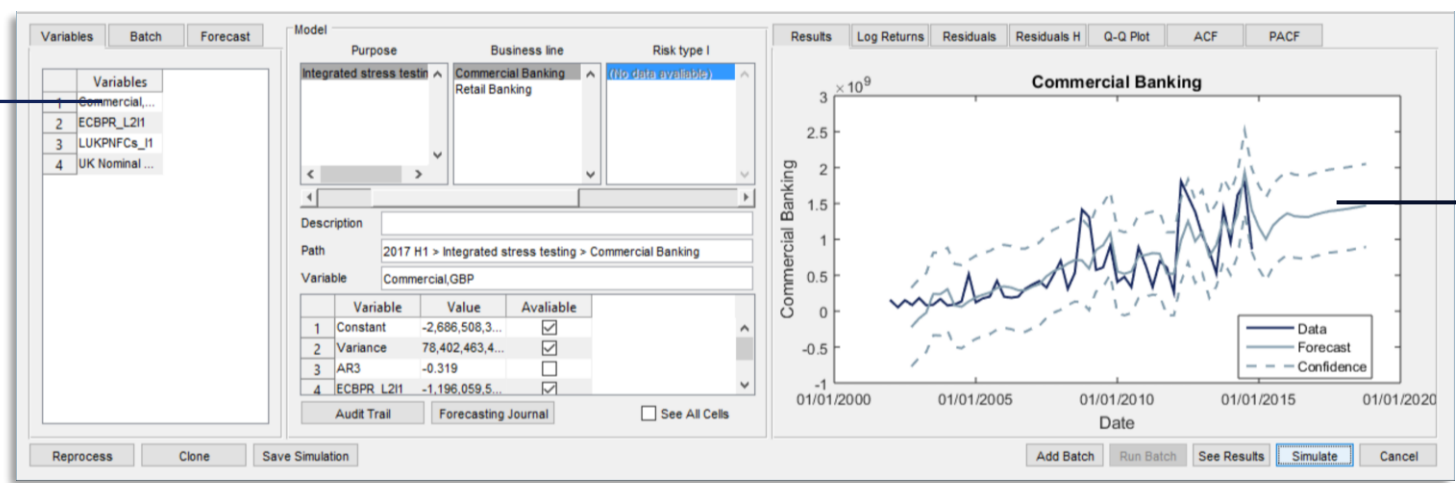


Our stress testing modelling permits to forecast losses under stress or base case scenarios as required

Projected macro variables for a recession scenario

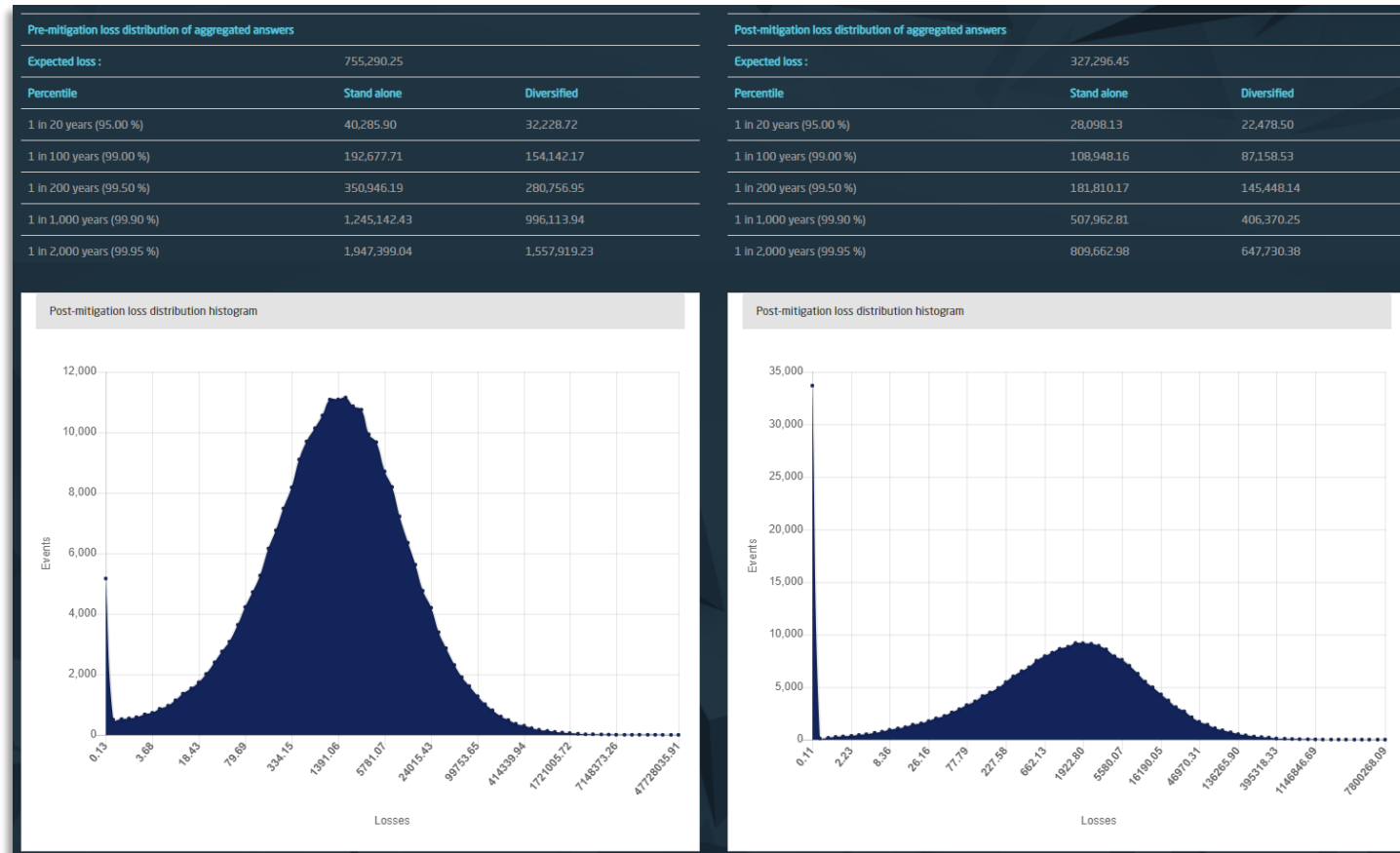


Projected macro variables for an expansion scenario



TAB's GRC Analytics integrates measurement and management showing risk profile before and after new mitigation plans and controls

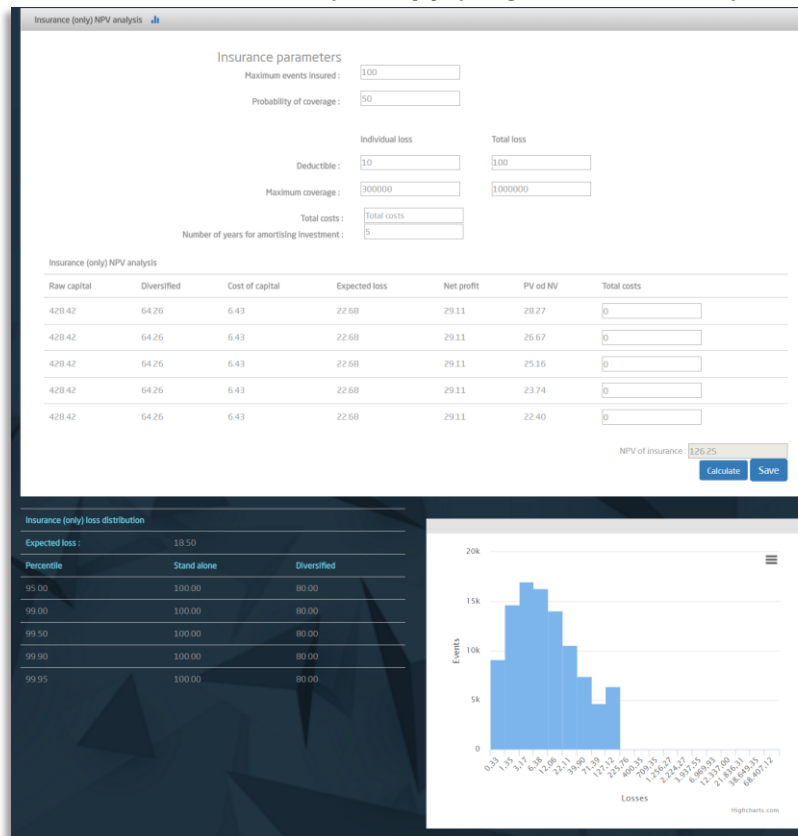
Risk monetary value based management permits to translate risk levels assumed into monetary values generating intuitive risk metrics which facilitate internal decisions and buy-in



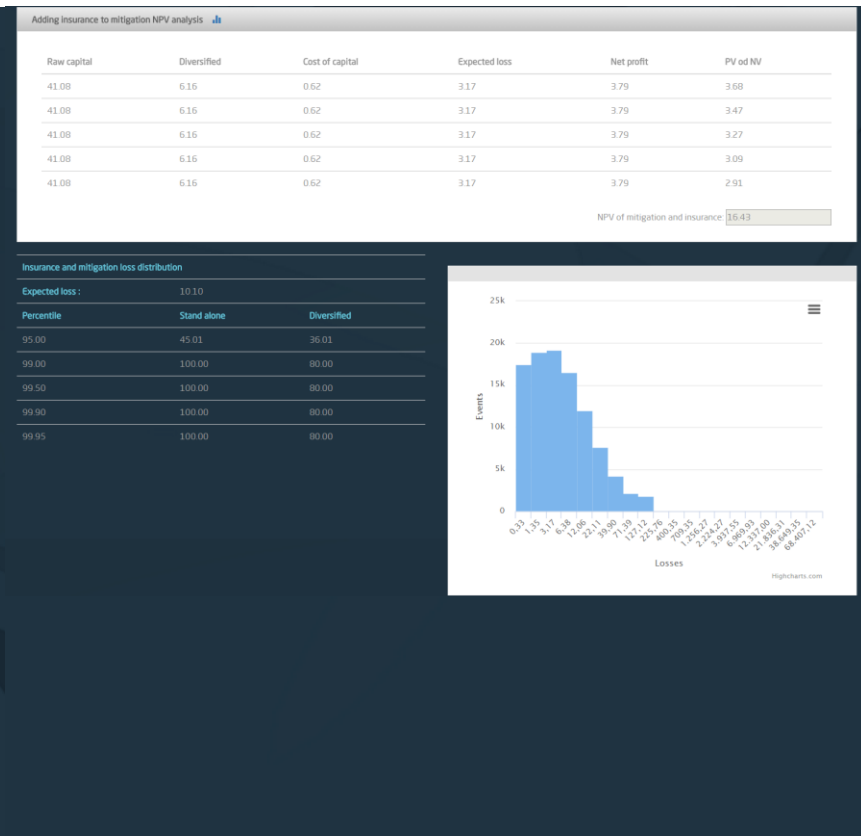
The difference in risk profiles is used, together with controls implementation costs and potential insurance to determine the NPV of mitigation actions

Economic metrics such as NPV (net present value) or capital requirements and better understood by upper management permitting an effective integration of the Risk management program into the daily management of the institution/company

NPV and loss analysis applying insurance only



NPV and loss analysis with insurance in the mitigation plan



Our GRC Analytics provides full reporting functionalities generating an exhaustive regulatory approval report derived from the audit trail with the push of a button

If the regulatory validation report is given to an external analyst such analyst would be able to exactly replicate the model results

Simulation report

Chapter 1. Simulation results

Table 1-1. Simulation Options

Simulation Options	
Date	24-Jan-2017
Number of replications	2,000,000
Random seed	931316783
Currency	EUR
Insurance	Not used
Simulation ID	RANO1177

Table 1-2. Capital Options

Capital Options	
Metric and allocation method	Economic Capital Expected Loss
Solvency standard	99.950 %

Table 1-3. Correlation

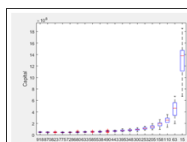
Correlation	
Correlation	t-Student
Degrees of freedom	14.23
Number of replications (copula)	2,000,000

Table 1-4. Capital Results

Cell ID	Modelling period	Model purpose	Business line	Risk type
126	2017 H1	Pillar 2	Agency Services	Process Management
127	2017 H1	Pillar 2	Trading and Sales	Systemic Failure
128	2017 H1	Pillar 2	Trading and Sales	Process Management
130	2017 H1	Pillar 2	Corporate Items	Process Management

LDA report

Chapter 1. 2016 H2 > Pillar 2 > Retail Banking > Process Management



Distribution: Lognormal, Fit Method: MLE, Minimum Excess: 15, Number of Boxes: 20, Iterations: 50, Quantile: 99.500, Percentage of sample: 80, Use bootstrapping: false

Losses

Table 1-2. Data filter

Variable	Condition	Value
Gross_Loss	Greater than or equal to	2000
B2ET	Contains	"Process"
B2BL	Contains	"Retail Banking"
Date_Reported	Greater than	2010/12/12
Date_Reported	Lower than	2017/01/01

Distribution fitting

Severity	
Truncation Limit Min	89,147.83
Truncation Limit Max	inf
Distribution	Lognormal
Fit	MLE

Scenario analysis report

Chapter 5. 2017 H1 > Scenario Analysis > All other ORCs > Info and Cyber

ORC description

Table 2-1. Basic cell information

Cell	2016 H2 > ORCs > Info and Cyber
Currency	USD
Lower truncation	0
Medium truncation	0
Maximum losses	2,012,755

Table 2-2. Data element weights

	Internal Data (%)	Risk score
Medium losses	0	100
Data elements weights	This box is filled out with the information tool that the user is supposed to fill in	

Risk scenarios (medium)

Table 2-4. Inputs to severity fit

Moment	Value
Frequency	3.91
Skewness	7.6
Kurtosis	81.2

Table 2-7. Percentile Determination Method: Worst losses by

Loss	in years
121,200,000	10
718,000,000	50
2,412,500,000	2,500

No filters have been applied to the data

OpRisk loss forecasting report

Chapter 1. Time Series fit results

Table 1-1. Fit results

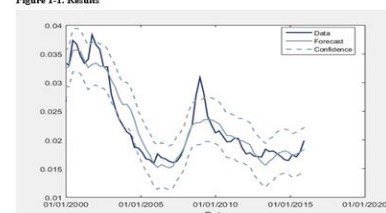
Parameter	Value	Standard Error
Constant	-0.0073	0.0016
10-Y Bond-Yield	0.2464	0.0158
RepoRate [A3]	0.0726	0.0098
HHDDupline-Debt-Y [L-1]	-0.0224	0.0049
Variance	3.2655e-06	1.2605e-06

Table 1-2. Statistics

Statistical	Value
Adjusted R-square	0.894
Anderson-Darling (p-value) [R]	0.808
Augmented Dickey Fuller (p-value) [R]	0.001
Augmented Dickey Fuller [R]	-4.2
Cramer von Misses (p-value) [R]	0.746
Cramer von Misses [R]	0.036
Durbin-Watson	0.885
Durbin-Watson (p-value)	0
F statistic	189.819
KPSS (p-value) [R]	0.1
KPSS [R]	0.072
Kolmogorov-Smirnov (p-value) [R]	0
Kolmogorov-Smirnov [R]	0.498
Leybourne-McCabe (p-value) [R]	0.01
Leybourne-McCabe [R]	0.46
MAE	0.001
MAPE	0.071
MSE	0

Plots

Figure 1-1. Results



Results Figures 1-2. Log Returns



Log Returns

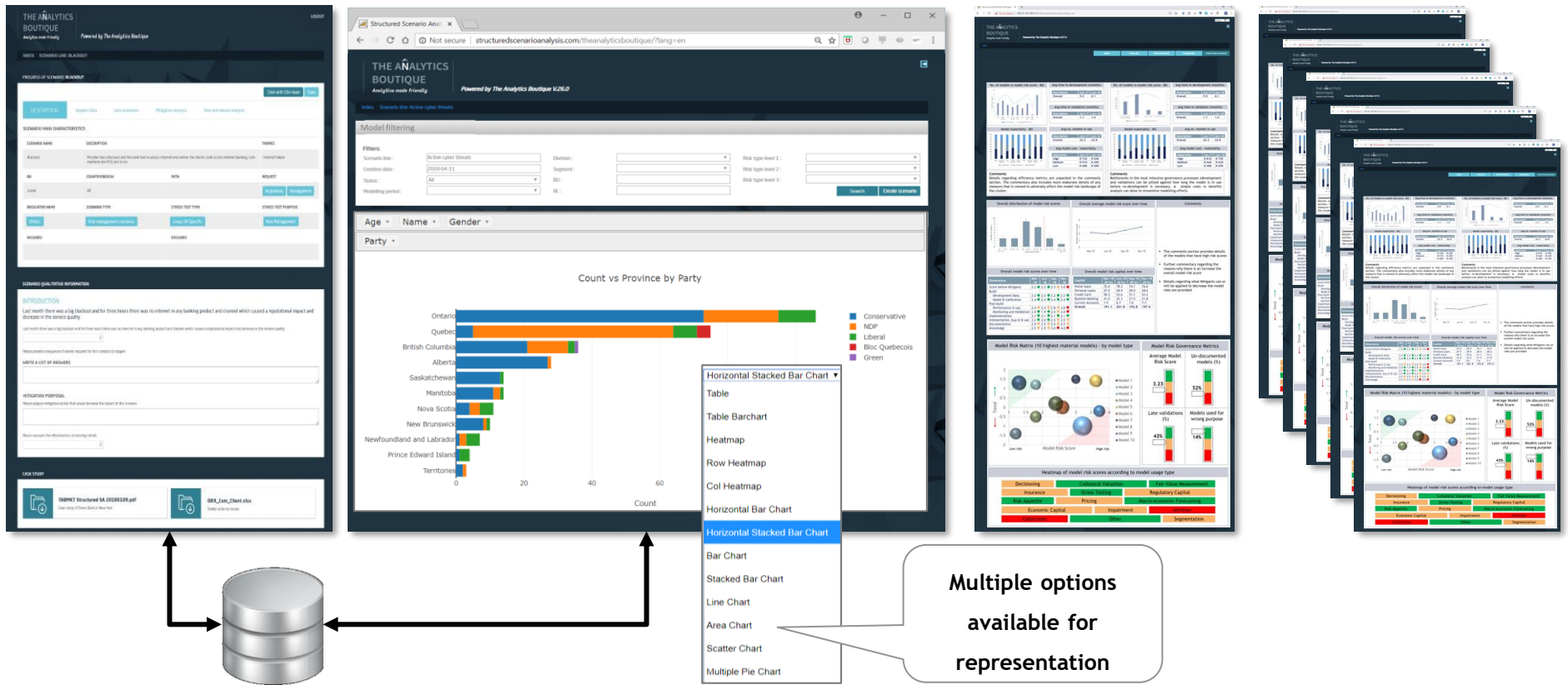
Risk management and measurement data is stored in TAB's GRC Analytics database and can be reported as desired using pivot tables and dashboards

1 Information is captured by users or produced by GRC Analytics forms and stored in a database

2 Pull information from database and create tables and charts as required using integrated reporting module

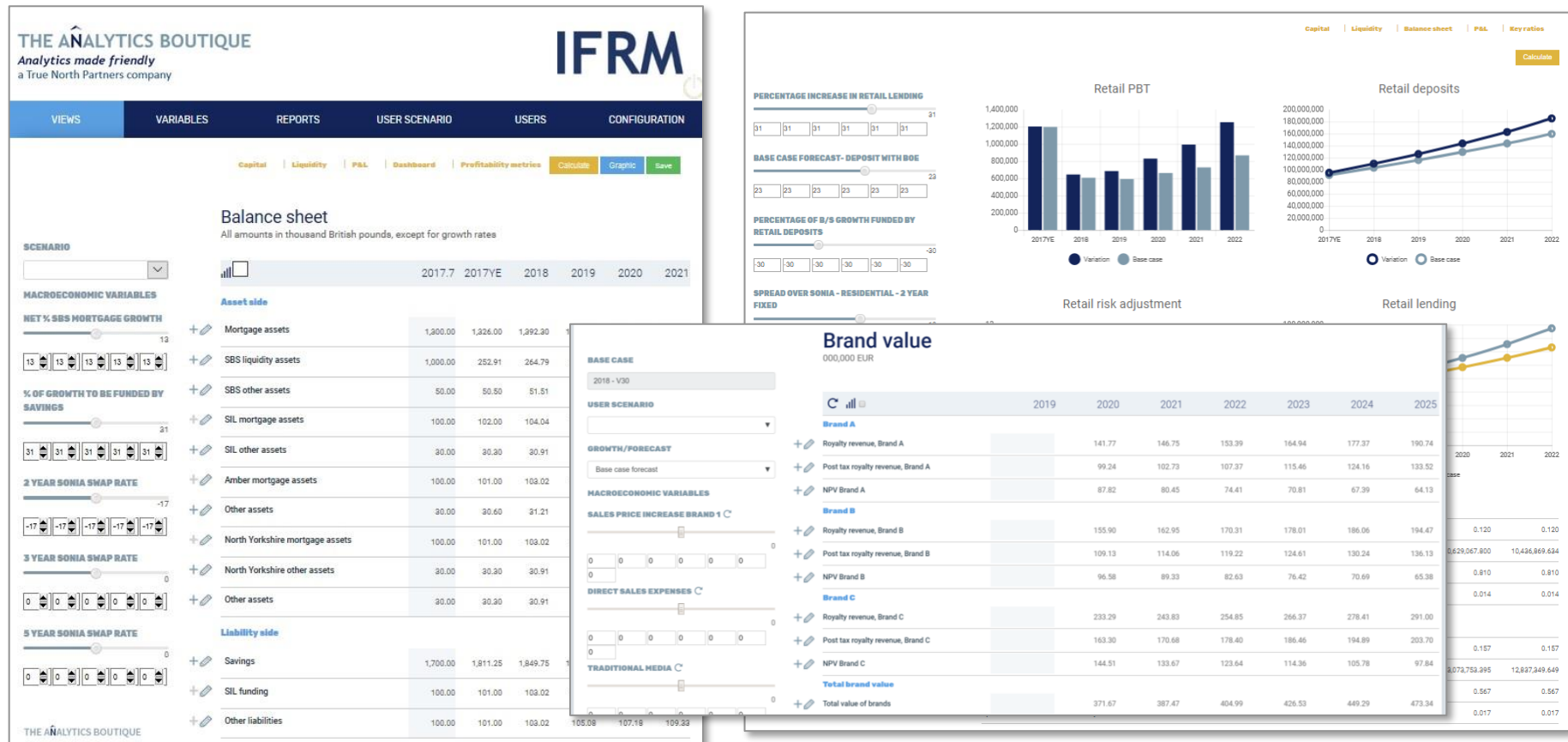
3 Graphs are grouped into dashboards

4 Multiple dashboards can be created



The created risk analytics models can be integrated into the financial planning of the company using IFRM for projecting P&L, BS and CF under any risk scenario

IFRM (Integrated Financial Resource Management TAB's stress testing and financial planning tool) integrates all risk Analytics such as as models, capital estimation process, stress testing..., into the financial planning process providing a consistent view of financial planning, strategy evaluation and risk measurement





Thank you.

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