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## Modernizing Credit Risk Analytics: From Risk Management for Banking into Stress Testing

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### ABSTRACT

Due to the continuous evolution of regulations issued around the world<sup>1</sup> and the constant advancements in methodology, the analysis of credit, market, and operational risk are complex topics that require tools to be updated during development, implementation, and even during the evaluation phase itself. These tools need to be customized to the specific needs of a variety of financial institutions and, yet they need to leverage a common platform containing common components needed for the analysis. SAS® Solution for Stress Testing is a powerful and highly customizable environment where several areas of interest (expected credit loss, risk weighted asset, economic capital, and more) can be evaluated. This paper presents some of the details about the evolution of credit risk analytics from SAS® Risk Management for Banking into SAS Solution for Stress Testing.

### INTRODUCTION

The heterogeneous and continuously changing regulatory environment, the development of new technologies, and the customer demand for customizations have favored the creation of several SAS products for the analysis of credit, market, and operational risk. Products like SAS® Credit Risk for Banking, SAS® Market Risk for Banking, and SAS® Firmwide Risk for Banking have been successful at helping customers in the past, but regulations, technology and needs have changed over time. Posed with the problem of reinventing themselves, these solutions showed some limitations. Although analytically advanced, these products are not simple solutions and a high level of expertise is often required to adapt them to the needs of customers. Moreover, these solutions were never engineered to operate in a common environment where tables, models, scenarios, and assumptions could be reused and shared across solutions.

SAS Solution for Stress Testing coupled with the new SAS® Risk Stratum is the new way of analyzing credit, market, and operational risk with attention on the following:

- governance
- data management

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<sup>1</sup> The European Banking Authority, the Board of Governors of the Federal Reserve System in the USA, the Bank of Japan, the Financial Policy Committee in the UK, the Australian Prudential Regulation Authority, the Hong Kong Monetary Authority, the Financial Supervisory Commission in Taiwan, the China Banking Regulatory Commission, the South African Reserve Bank, the Banco Central do Brazil, and many others including the International Monetary Fund.

- configuration and customization
- traceability
- reusability

## GOVERNANCE

SAS Risk Management for Banking provides analytical tools that help analysts complete specific jobs: making decisions, preparing reports, or simply monitoring the business. Each of these jobs typically requires different analyses, possibly performed in a specific order and by specific analysts. Even though the sequence and the roles required to perform a specific analysis might be obvious, SAS Risk Management for Banking does not provide a full effective governance tool. Even though tabs are placed in a logical order, nothing prevents different users with different roles to perform analyses that are either inconsistent with the role associated with the user (for example, a data analyst trying to perform tasks attributed to a quantitative analyst) or inconsistent with the natural chronology (for example, trying to approve the results of the models before the input data to the model are deemed “production”).

The only tools that help governance in SAS Risk Management for Banking is the concept of a playpen. The playpen is a reserved area where users can customize models, modify data and, more in general, reach conclusions in an independent way. Once analysts working in a playpen are satisfied with their analyses, they can choose to publish them. If properly managed, playpens can, to some extent, partially mimic the functionalities of a workflow.

SAS Solution for Stress Testing embraces the concept of governance at its core. Workflows can be created and modified, and each step in the workflow represents an analysis that can be configured in such a way that only specific users with a given role can execute it. Figure 1 shows the workflow template available in SAS Solution for Stress Testing. Notice that each of the steps can be executed only by pre-defined roles. For example, the analyst in charge of processing the data is not necessarily the same person in charge of defining the business growth assumptions in the business evolution plan. Also, it is important to notice that some steps must precede some others; for example, in order to perform the credit risk analysis contained in the stress credit risk step you first need to configure the business evolution plan and master risk scenarios.

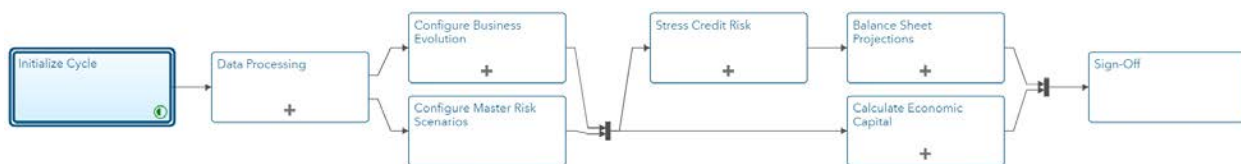


Figure 1: Template Workflow Available in SAS Solution for Stress Testing

## DATA MANAGEMENT

SAS Risk Management for Banking requires data to be uploaded in prescribed tables and structure. The data in these tables is generally sourced from external sources. The data first flows to the SAS® Detail Data Store for Banking and using an out-of-box ETL it is extracted to what is called the SAS® Solution Data Mart. This data mart contains staging data (data extracted from external sources) and configuration data (data installed with the product).

Using the SAS® Deployment Manager, a shared data mart or a private data mart can be created. The data for analysis is directly taken from these data marts.

SAS Solution for Stress Testing does not prescribe any strict data model. The tables and columns in the tables are those that are expected by the analytics method that is setup. For example, out-of-the-box the sample tables contain a table called CREDIT\_PORTFOLIO, which is a key table for credit risk analysis. The name of the table could be anything. The columns in the table are set up to support the modeling system in SAS® Model Implementation Platform. If using the out-of-the-box structure, the user can replace almost 80% of the columns that are used for reporting or cross-classification analysis. Figure 2 shows the flow of data in SAS Solution for Stress Testing.

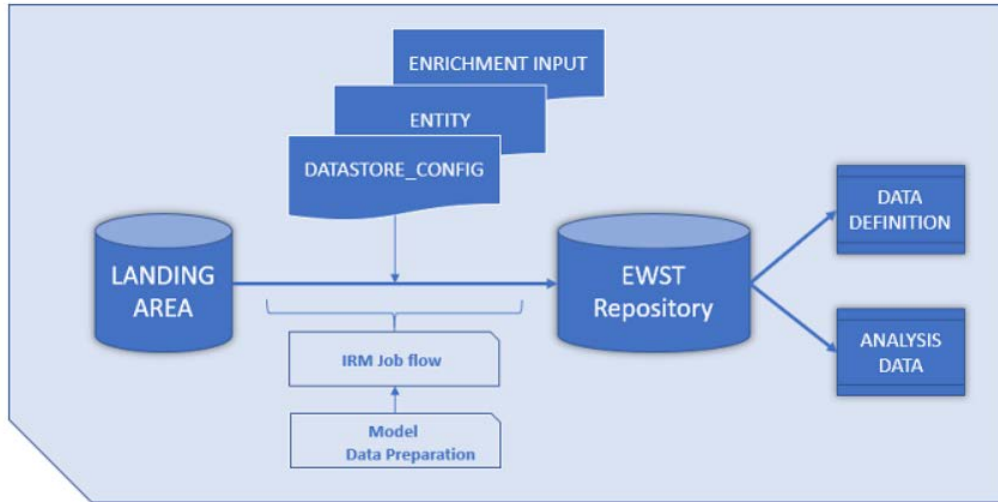


Figure 2: Data Flow in SAS Solution for Stress Testing

Beside efficiently storing and keeping track of versioning, SAS Solution for Stress Testing adds the possibility of checking, and possibly improving, the quality of the data. In the workflow represented in Figure 1, the second step is named Data Processing. This is a generic collection of tasks suitable for verifying and modifying data within the solution. Figure 3 provides the details of this sub-flow.

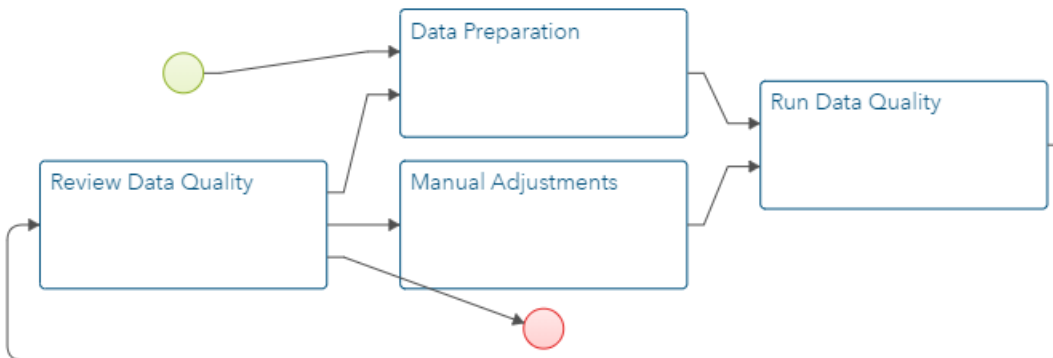


Figure 3: Data Processing Details in SAS Solution for Stress Testing

Notice that the data processing capabilities built-in SAS Solution for Stress Testing are not meant to substitute the typical data preparation work that should precede the load in the solution. These capabilities should be viewed more as a tool to apply minor modifications and facilitate the creation of what-if analyses.

## CONFIGURATION AND CUSTOMIZATION

In SAS Risk Management for Banking, anything that relates to configuration resides in tables within the data mart. When a user makes a playpen, a copy of the configuration is created for the playpen. The user can modify the configurations (private playpen) and use them in the analysis. It is important to emphasize that the nature of configuring within SAS Risk Management for Banking is static. For repetitive and immutable tasks this static approach is very efficient: if there is no need to change the analysis parameters, there is no need to change the configuration table.

The static configuration becomes cumbersome when the analyst needs to change it on a regular basis: either because the analysis is still in the exploratory phase or because several what-if analyses are needed. SAS Solution for Stress Testing aims at solving this problem by enabling configurations both statically and dynamically. Static configuration works similarly to SAS Risk Management for Banking: the user needs to modify a table. Dynamic configuration is a new concept that integrates perfectly within SAS Solution for Stress Testing.

There are several examples of dynamic configuration and each of them is characterized by a different level of flexibility. For example, when configuring the business evolution plan, SAS Solution for Stress Testing prompts the user with a user interface component that essentially parses the user options and creates a static configuration table. This type of dynamic configuration is obviously characterized by a low level of flexibility because the choices are still stored in something that resembles a table. Figure 4 shows the configuration of the business evolution plan within SAS Solution for Stress Testing based on the counterparty type: Corporates and Retail. The specified assumption states that the retail portion of the portfolio (currently worth \$7,680,967.09) will grow 2%, 3% and 4% over the next three years.

Counterparty Type	Unpaid Balance Amount	Change Type	YEAR 1	YEAR 2	YEAR 3
Corporates	56,026,235.19	Relative	2%	2%	3%
Retail	7,680,967.09	Relative	2%	3%	4%

Figure 4: Configuration of the Business Evolution Plan in SAS Solution for Stress Testing

A more flexible example of dynamic configuration is represented by the possibility of changing the staging rule of the expected credit loss at run-time without publishing a new SAS® Model Implementation Platform modeling system. This example of dynamic configuration is characterized by a high level of flexibility: several what-if analyses can be configured and executed in a matter of seconds. Figure 5 shows the configuration of the staging rules for the evaluation of the expected credit loss. In this case, it can be noticed that an instrument is labeled as Stage 1 if it is rated as state 5 or better. Other parameters for more refined staging rules follow, allowing the analyst great flexibility when defining the staging rules.

ST - EBA 2018 - ECL & RWA Model Parameters:

Stage 1 credit state threshold: *	5	Downgrade threshold: *	2
PD threshold: *	0.375	PD deterioration threshold: *	0.003
Cashflow data:		Generate detailed output?: *	N
Time interval: *	Year	Max simulation horizon: *	MAX
Number of grid nodes: *	ALL	Number of threads: *	8
Output currency: *	USD		

Figure 5: Configuration of the Staging Rules for the Evaluation of the Staged Expected Credit Loss

## RISK ANALYSIS

At the core of both SAS Risk Management for Banking and SAS Solution for Stress Testing, there are analytical tools that help analysts make decisions, prepare reports, or simply monitor the business. The form of these tools is very heterogeneous, but often it resembles an analytical model. Therefore, being able to either customize an existing model or add a new model becomes crucial. Overall, SAS Risk Management for Banking focuses on the possibility of executing pre-configured instances while SAS Solution for Stress Testing is designed with the goal of allowing analysts to configure the models at run-time.

The concept of a new model is vague; therefore, it makes sense to analyze in more details when and where SAS Risk Management for Banking and SAS Solution for Stress Testing differ. A new model can be obtained by the following:

1. Changing parameters and scenarios: easy under SAS Risk Management for Banking and SAS Solution for Stress Testing:
  - a. In SAS Solution for Stress Testing solution, there is the option of static and dynamic configuration.
2. Import models from other SAS products:
  - a. In SAS Risk Management for Banking, this task is related to the interaction with PROC MODEL.
  - b. In SAS Solution for Stress Testing, you can import models from the SAS Model Implementation Platform user interface.
    - Notice that this implies the possibility of taking advantage of PROC HPRISK.
3. Import models from non SAS products:
  - a. This is not possible in SAS Risk Management for Banking.
  - b. In SAS Solution for Stress Testing, you can import non SAS models (for example, Python models).
4. Implement predefined functions:
  - a. In SAS Risk Management for Banking this is an advanced task.
  - b. In SAS Solution for Stress Testing, you can use either the SAS Model Implementation Platform user interface or you can write your own DATA step.
5. Create a new model:

- a. In SAS Risk Management for Banking, this is a hard task and typically it requires help from consultants or a high level of expertise.
- b. In SAS Solution for Stress Testing, there are several ways to add new models and often it can be done without the help of consultants:
  - create a new model through the SAS Model Implementation Platform user interface
  - create a new model through BASE SAS® or any other SAS product
  - create a new model in non SAS based languages (for example, Python)

## TRACEABILITY

SAS Risk Management for Banking does not have a strong emphasis on traceability. Typically, it is up to the judgment of the analyst to make sure that configurations used in an analysis are preserved. On the other hand, SAS Solution for Stress Testing and its components have been designed with traceability in mind.

The main idea around SAS Solution for Stress Testing is that tables are immutable: once a data set is created, it cannot be changed. If a modification is needed, then a new version of the table is created. This allows the analyst to be able to retrieve any single piece of information used in a given analysis.

In addition to the data being immutable, SAS Solution for Stress Testing keeps track of the following:

- OUTPUT tracking: the process that created a data set
- INPUT tracking: the process that consumed a data set

This tracking tool is powerful and helps the analyst understand the following:

- where tables are created and consumed
- how results are consumed
- whether results are reused across different projects

Figure 6 shows an example of how SAS Solution for Stress Testing represents the relationships between analyses that create data sets and analyses that consume data sets. In this example, the analyst has performed the following tasks:

- 1) initialized the cycle
- 2) loaded the portfolio data
- 3) configured the following:
  - a. business evolution plan
  - b. master risk scenario
  - c. executed a credit risk analysis using a European Banking Authority (EBA) 2018 model
- 4) generated synthetic instruments based on the business evolution plan (BEP) assumptions
- 5) generated detailed data for the expected credit analysis

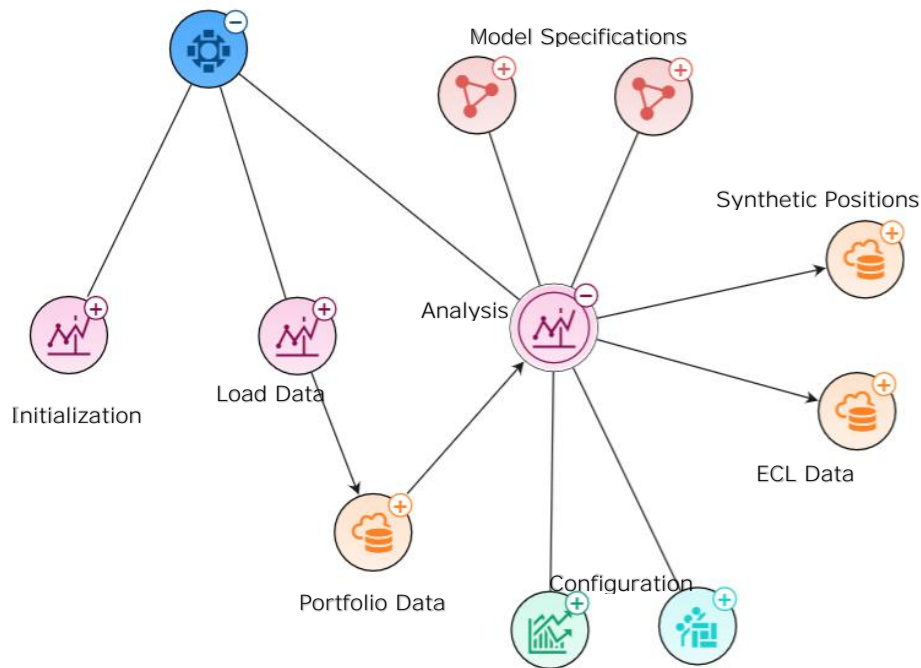


Figure 6: Graphical Representation of Tracking within SAS Solution for Stress Testing

In addition to tracking data sets and analyses within SAS Solution for Stress Testing, the analyst can monitor the results of analytical models through the SAS Model Implementation Platform user interface (if a SAS Model Implementation Platform model was executed). Figure 7 shows the SAS Model Implementation Platform execution of the credit risk analysis model shown in Figure 6.

Model Implementation

Filter My Runs ▾ ✦ 🔍

<input type="checkbox"/>	Name	Status	Results	Created By	Completed
<input type="checkbox"/>	ST_SCEN_RUN_20181231_10003	✔ Completed	📄 📄 📄	RGF Administrator	Dec 30, 2019 01:15 PM
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Figure 7: Execution of a Credit Risk Analysis within SAS Model Implementation Platform

## REUSABILITY

At the core of SAS Solution for Stress Testing is SAS Risk Stratum. This new platform leverages the functionalities of three pre-existing SAS products: SAS® Risk Governance Framework, SAS® Infrastructure for Risk Management, and SAS Model Implementation Platform. SAS Risk Stratum platform also includes a common repository of business objects that are used by SAS Solution for Stress Testing and, possibly, by any other solution built on SAS Risk Stratum.

For example, the need of a master risk scenario is not unique to SAS Solution for Stress Testing. It is also needed in SAS® Solution for CECL and SAS® Solution for IFRS 9. Since

SAS Solution for CECL and SAS Solution for IFRS 9 are also built on SAS Risk Stratum, the master risk scenario business object defined in SAS Risk Stratum can be reused wherever needed. There are several advantages for a centralized repository of business objects. Development and maintenance of a shared component require, at the aggregate level, fewer resources. From the customer point of view, a shared object requires a similar training when switching from one solution to another, therefore reducing, at the aggregate level, the amount of training needed.

There is a second important benefit from using solutions built on SAS Risk Stratum. By design, this platform allows sharing information across different solutions. For example, if a master risk scenario is relevant for both SAS Solution for Stress Testing and SAS Solution for IFRS 9, the common SAS Risk Stratum platform of these solutions is able to share the master risk scenario. Therefore, analysts can set up scenarios in one solution and allow other analysts using a different solution to access those scenarios in their analyses.

Figure 8 shows a simplified representation of how SAS Risk Stratum provides a common layer on which different solutions with similar needs can be built. It is worth noticing that since SAS Risk Stratum is common to different solutions, the capability of sharing information across solutions is part of the SAS Risk Stratum design.



Figure 8: Simplified Representation of the Interaction between SAS Risk Stratum and SAS Solution for Stress Testing

## CONCLUSIONS

SAS Solution for Stress Testing represents a powerful product for the analysis of credit, market, and operational risk. The solution clearly takes advantage of some features derived from SAS Risk Management for Banking. At the same time, it leverages the benefits of SAS Risk Stratum and **it embraces the new idea of a solution being closer to the users’ needs.**



## CONTACT INFORMATION

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