Moody's Analytics

Kenya Bankers Association

Better Faster Decisions

East Africa Series: Corporate Credit Risk Scoring

March, 2021

Moody's Analytics

Better Faster Decisions

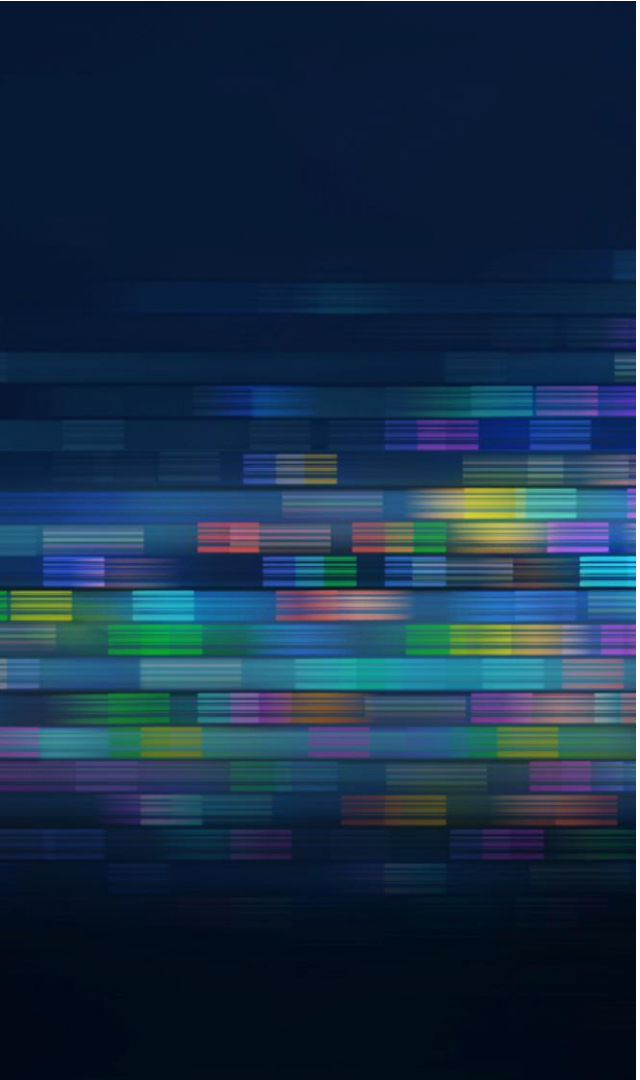
Model Lifecycle: From Development to Validation Process

David Goncalves, Director, Advisory Services

March, 2021

Agenda

1. Modelling Approaches
2. Model Management
3. Model Validation



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Modelling Approaches

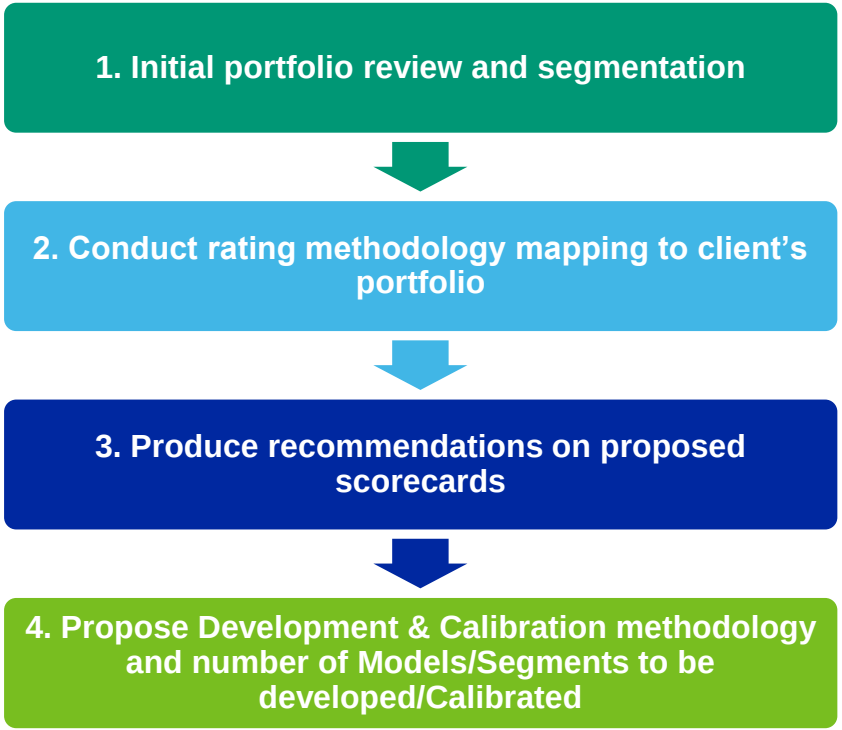
Portfolio segmentation

Review organizations' business structures, credit risk profiles, and relevant portfolios in order to determine:

- Portfolio structure
- Industry coverage and concentrations
- Data availability across different industry segments.
- Alignment of Risk Drivers
- Materiality of each segment (Exposure and number of obligors)
- Pros and Cons of each modelling approach per segment

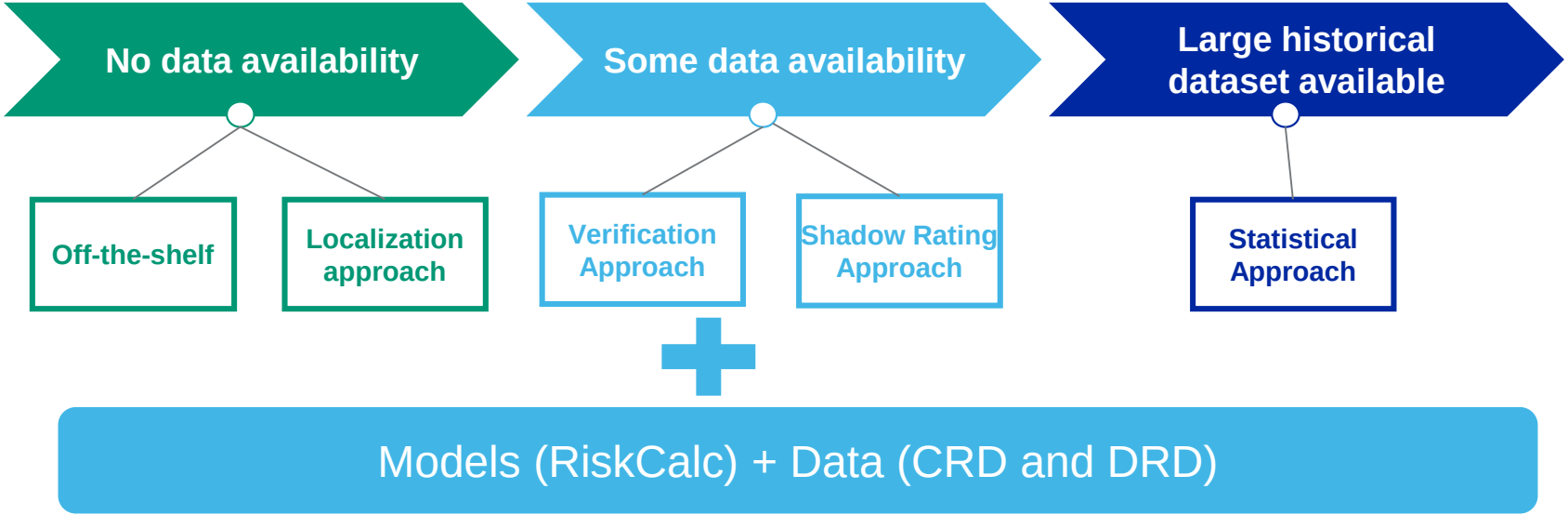
Provide recommendations for ideal credit risk framework in line with client business requirements.

Typical project structure



PD modelling approach: driven by data availability

The approach to PD modelling depends on the amount of existing data in the organization's respective portfolio:



Data Availability: The two key elements are number of obligors and number of defaults in the past (for example over the last 5 years) per relevant portfolio.

IRB Accelerator : The use of an off the shelf model as for Example RiskCalc as the starting point can reduce the Development Timelines and increase the statistical robustness of the final model

Verification approach overview

Moody's alternative to the Statistical Approach for low-default portfolios

STEP 01

Scorecard Design

Design initial model based on the expertise and judgment of bank's credit professionals and Moody's
Leverage Moody's rating methodologies for factor selection
Moody's provide expertise on rating model design and feedback on the benefits and drawbacks of various approaches
The collaborative process ensures understanding of your objectives, history and portfolio

STEP 02

Single Factor Analysis

Based on an initial data collection, all inputs, Moody´s will analyze the following dimensions:

- Factor Distribution, Information Entropy, Rank Ordering, Factor Correlation, PD relationship, Predictive Power
- Based on expert rank ordering and benchmark ratings

STEP 03

Weight Optimisation

Genetic Algorithm: which performs a search to find the combination of factor weights for highest model performance
Tightening of the search space results with additional trade-off in model performance
The approach provides the client with the opportunity to incorporate best business practices and knowledge in the optimisation process integrating empirical modelling with expert judgment

STEP 04

Mapping Optimisation

Mapping Optimization is the process of mapping the scorecard model output (Score per client) to expert grades and associated PDs
This mapping process involves mathematical optimisation and manual adjustments that will ultimately minimise differences between the scorecard with client expert judgement-based ratings while ensuring a scorecard average PD equal to the Central Default Tendency

STEP 05

Reliability tests and Model Documentation

Bootstrapping is employed to leverage available data in an effort to reduce dependency on the original sample dataset and define confidence intervals to assess the consistency of the model.
A comprehensive report outlining the core methodology and results, and an Excel-based scorecard that the client can use in making credit decisions.

Verification Approach - Custom Project Finance PD for IRB

Case Study

Client Situation

- The client is a major Global Bank with a Project Finance Portfolio in EMEA, Americas and Asia
- The client wanted to evolve from Slotting Criteria expert based scorecard into a Advance IRB model
- The rationale for the decision was to increase the IRB coverage of the portfolio and reduce the capital spending in the segment
- Moody's suggested the Verification Approach, due to the lack of past default information (i.e. less than 20), in combination with the use of Moody's Project Finance Consortium data.

Solution Provided / Key Highlights

- Development of 5 scorecards to cover the segment, following a segmentation analysis, with final deliverables including model documentation, prototype and development codes.
- Supported the institution throughout the internal validation process and the final outcome was a PRA approval for capital calculations.

Analytical Approach

Workshop

- Review of the client portfolio to understand the key industries and size distribution
- Mapping of industries from the client portfolio to Moody's Investors Services rating methodologies to understand the key risk drivers relevant for the client portfolio
- Discussion of factors to include in scorecards

Single Factor Analysis

- Discussion and selection of Overlay Factors
- Balancing of factors and initial weight assessment by expert judgment

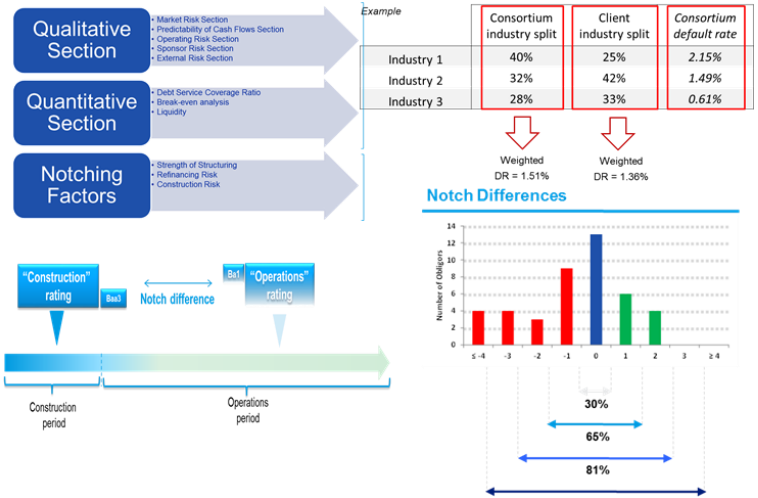
Weight Optimisation

- Optimise the scorecards by maximizing alignment between scorecard result and benchmark ratings
- Use of external ratings to help determine the benchmark ratings

Calibration

- Definition of Central Default Tendency taking into account Consortium Default Rate information as well as internal
- Alignment with the expert based benchmarks

Illustrative Output

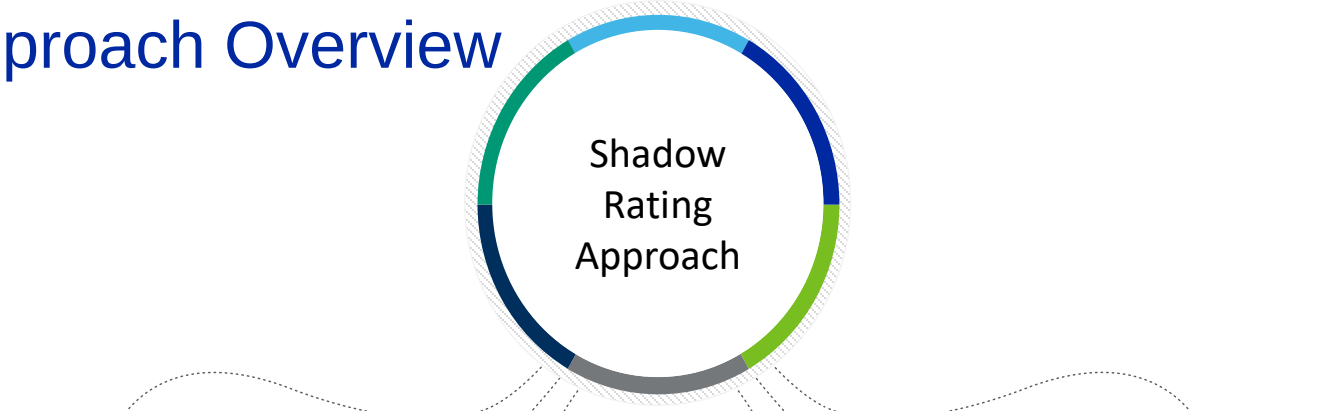


Shadow Rating Approach Overview

- For portfolios were external ratings are available, as for Example Insurance, Banks, Sovereigns

Key Characteristics of approach

- » External Rating used as target variable
- » Use of Historical information matching the rating time span
- » Replication of rating agency but allows for greater control of final model



Sample Definition

Representative sample from Moody´s Default and Recovery Database

PD estimation

Determination of appropriate PD for each rating Class

Cohort or Duration Approach

Data collection and Review

Collection of historical financial-economic information

Single Factor Analysis

Factor Transformation

Position Analysis

Alignment with external rating

Factor correlation

Model Estimation

Linear Regression

Exhaustive Search

Adherence to statistical requirements (VIF and significance)

Calibration and Validation

Tranching

Incorporation of group and sovereign support

Bootstrapping

Internal Rating Shadow Rating Approach / PD Model Development for Sovereign Counterparts

Case Study 4

Client Situation

- The client is an European Insurance Company
- The client wanted to develop a customized Sovereign Probability of Default (PD) model for developed countries
- The model is intended to assess the creditworthiness of sovereign governments as the client holds debt issues by this government
- As observed sovereign defaults are very limited, especially for developed economies, shadow rating approach (SRA) was followed to leverages External Credit Agency (e.g. Moody's) information

Solution Provided / Key Highlights

- A PD model prototype in MS Excel for estimating PDs and ratings and detail model development report documentation
- The model comprises of factors covering different broad categories e.g. Economic strength, Fiscal strength, Institutional strength, and Susceptibility of event risk
- Model covers key financial factors e.g. Terms of Trade, Average Real GDP Growth t-4 to t, Total Economy Financial Net Worth/GDP (%), and Inflation Volatility t-4 to t, and key qualitative indices e.g. WGI Global Competitiveness Index

Analytical Approach

Data Collection

- Discuss and finalize with client key data requirements for sovereigns (External Ratings, Historical Financials, Qualitative indices e.g. WGI Government Effectiveness Index)
- In the SRA, PD is attached to each rating. For this, a transition matrix was estimated using Moody's DRD data

Data Preparation

- Leverage all rated counterparties including sovereigns in DRD, instead of using only sovereigns, to avoid small sample bias
- Attach PD to each rating class using duration based migration matrix estimation method
- Cleanse model development data and prepare sample

Model Development

- Single factor analysis: assess each factor e.g. factor transformation, alignment with external ratings, PD relationship, factor correlations
- Multi-factor analysis: Missing value treatment, linear regression between log(PD) and transformed factors
- Model selection: High R-sq, high alignment with ratings, correct sign of coefficients

Validation and Calibration

- Bootstrap to asses robustness of coefficients
- Validate model on crisis period i.e. 2009-2012
- Piecewise linear regression between model output and log(PD) to best align the predicted ratings with external ratings
- Compare model predicted ratings with Moody's ratings for the country of Insurer
- Perform peer comparison

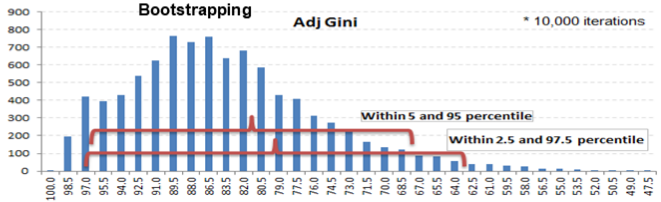
Illustrative Output

Model

Section	Weight	Category	Weight
Quantitative	75%	Economic Strength	37%
		Fiscal Strength	17%
		Institutional Strength	13%
		Susceptibility to Event Risk	8%
Qualitative	25%	Economic Strength	3%
		Institutional Strength	18%
		Susceptibility to Event Risk	4%

Predicted rating for Country X

Year	Moody's rating	Model rating
2002	Aa2	Aa2
2003	Aa2	Aa2
2004	Aa2	Aa2
2005	Aa2	Aa2
2006	Aa2	Aa1
2007	Aa2	Aa1
2008	Aa2	Aa1



Statistical approach:
RiskCalc Emerging Markets Model

A RiskCalc model intended to be used on all the Emerging Markets where there is currently no RiskCalc country model

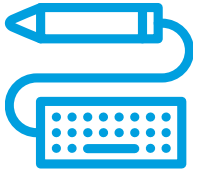
Built with data from more than 20 Emerging Markets, using both public and private firm data. Sample is constructed in a way to mitigate the domination from any single country

01

Financial Item inputs are common to the accounting standards across countries and are easy to find. Financial ratios are simple and robust

02

Designed to deliver sizable predictive power across countries/ regions



03

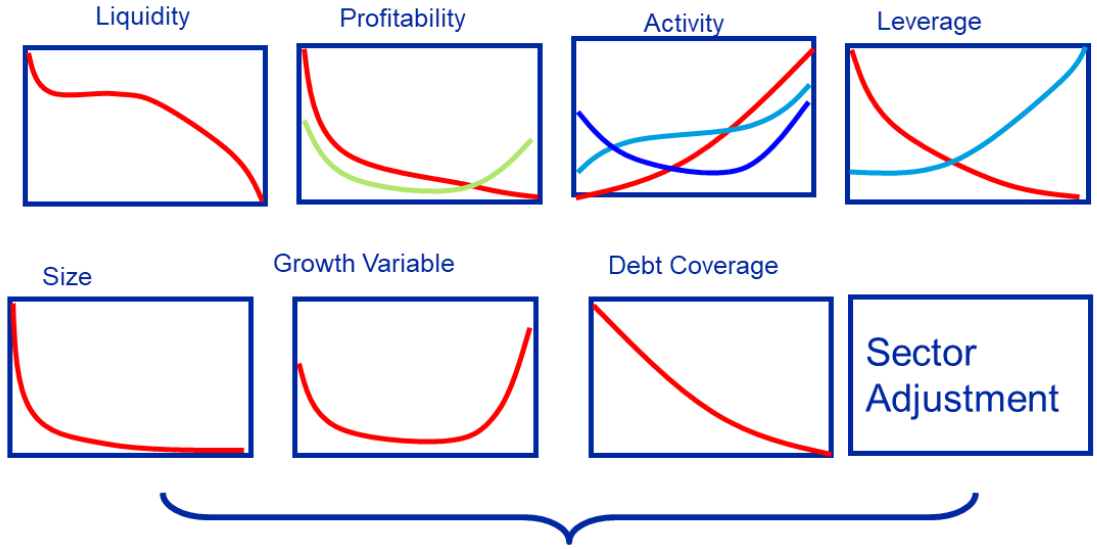
EDF measurements at 1-year horizon are calibrated to 4%. Given the heterogeneity across countries, Model outputs will be customizable to reflect different PD levels

04

RiskCalc: Identifying the Relevant Ratios to Estimate Default

We first identify broad categories of ratios relevant to default.

We evaluate as many ratios per risk factor as possible.



Within each category, we then choose a limited no ratios which have:

- High predictive power
- Data availability
- Intuitive behavior

Probability of Default: **EDF**

$$FSO\ EDF = F\left(\Phi\left(\sum_{i=1}^{N}\beta_i T_i(x_i) + \sum_{j=1}^{K}\gamma_j I_j\right)\right)$$

- Each transformed ratio [T(xi)] is included in the regression, along with indicator variables for each industry [Ij]
- F is the Final Calibration taking into account the Central Default Tendency

RiskCalc Financial Inputs and Ratios and Weight

Emerging Market Model Input List

Cash and Marketable Securities
Inventory
Current Assets
Total Assets
Current Liabilities
Total Liabilities
Net Sales
Net Sales Last Year
Operating Profit
Interest Expense
Net Income
Amortization & Depreciation
Industry

Section	Ratio	Weight
Size	Sales	3.70%
Leverage	Total Liabilities / Total Assets	18.69%
Growth	Sales Growth	9.45%
Profitability	ROA	19.14%
Activity	Inventory / Sales	11.71%
Debt Coverage	EBITDA / Interest Expense	18.61%
Liquidity	Current Assets / Current Liabilities Cash & Equivalents/ Assets	18.71%

Key principles when using external Data/Models

Institutions should leverage on external data to mitigate data shortage and augment internal data

Validated

Model performance to be tested on Institution Portfolio

Model re-estimated with a new representative portfolio if required

Representative

The data should be compared between external source and internal portfolio (Ex. Industries/Countries)

This assessment should also include an evaluation of default definition and the Credit Origination Policies

Incorporate Internal Profile

Even when using external input information the Institution is expected to combine it with the Internal Criteria.

Important to evaluate the alignment of the model versus internal expertise and adjust if needed

Ownership

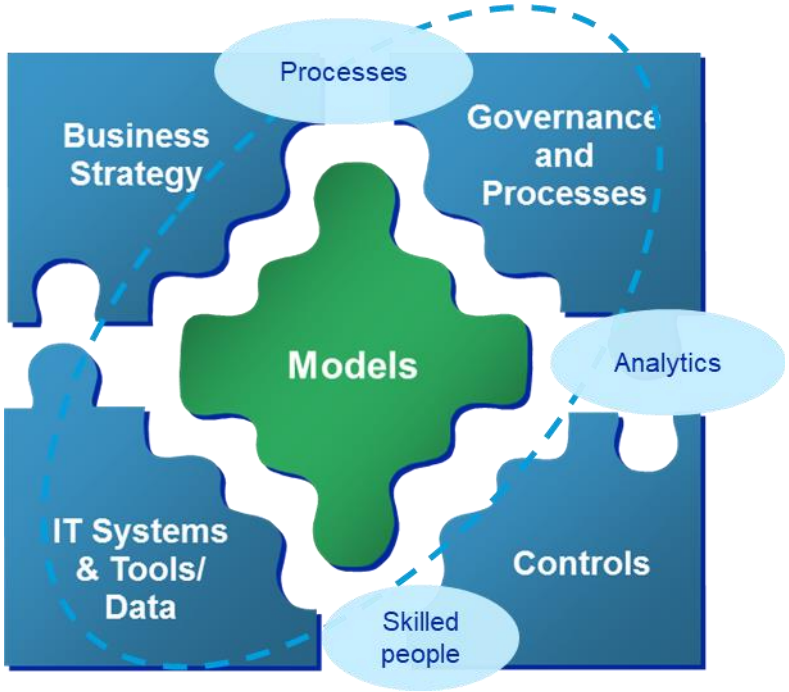
Institutions are expected to have a good degree of understanding of the external information. Avoidance of Black Box

Solutions should be auditable and replicable

Integration of models in the institution

The modelling techniques need to fit the institution, both from an IT and user perspective, and the following points should be taken into account

- Balance between the statistical sophistication and the data available
- Models sophistication can grow through different generations
- Inclusion of the Key Stakeholders (Risk, Credit, Business) in the modelling process
- Transparency in the model calculation and final output that can be understood
- Importance of capturing the day to day credit/risk assessment
- Impact of the rating process, for example filling in the qualitative factors, in the model quality



Lessons learned from practice

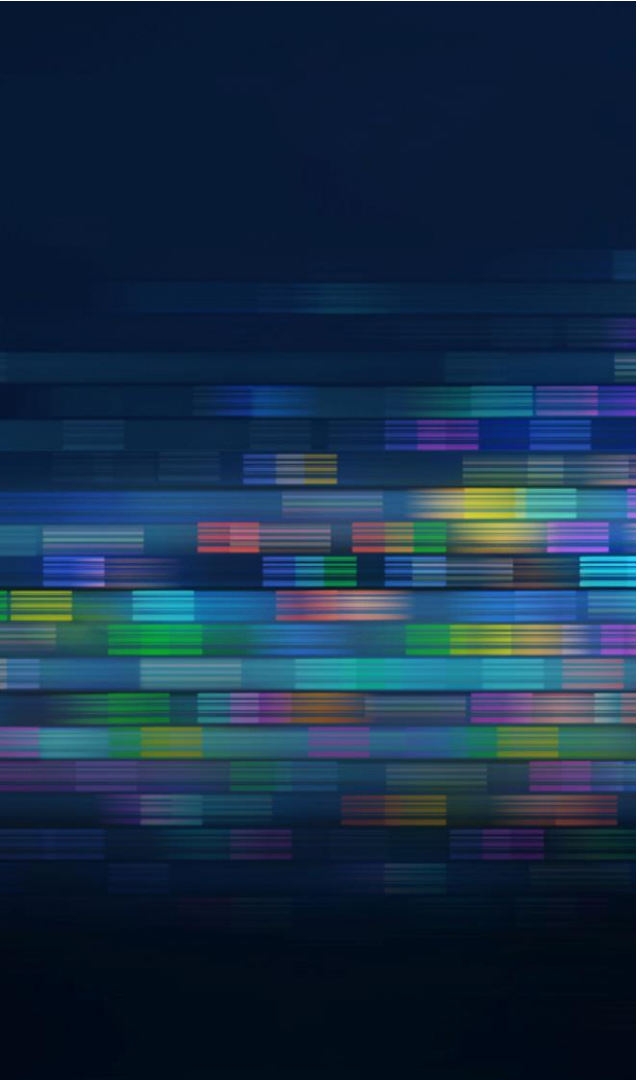
First focus should be the risk drivers and not the data available

Be prepared to combine different methodologies – Use data where available and complement always with expert judgment to cover all risk drivers

Plan for the second model generation and start collecting data for the future

When using expert judgment collect opinions of a group of persons and not a single individual

Review outliers at the end and identify a clear reason for their existence (Model Limitations) possibly defining the override policies



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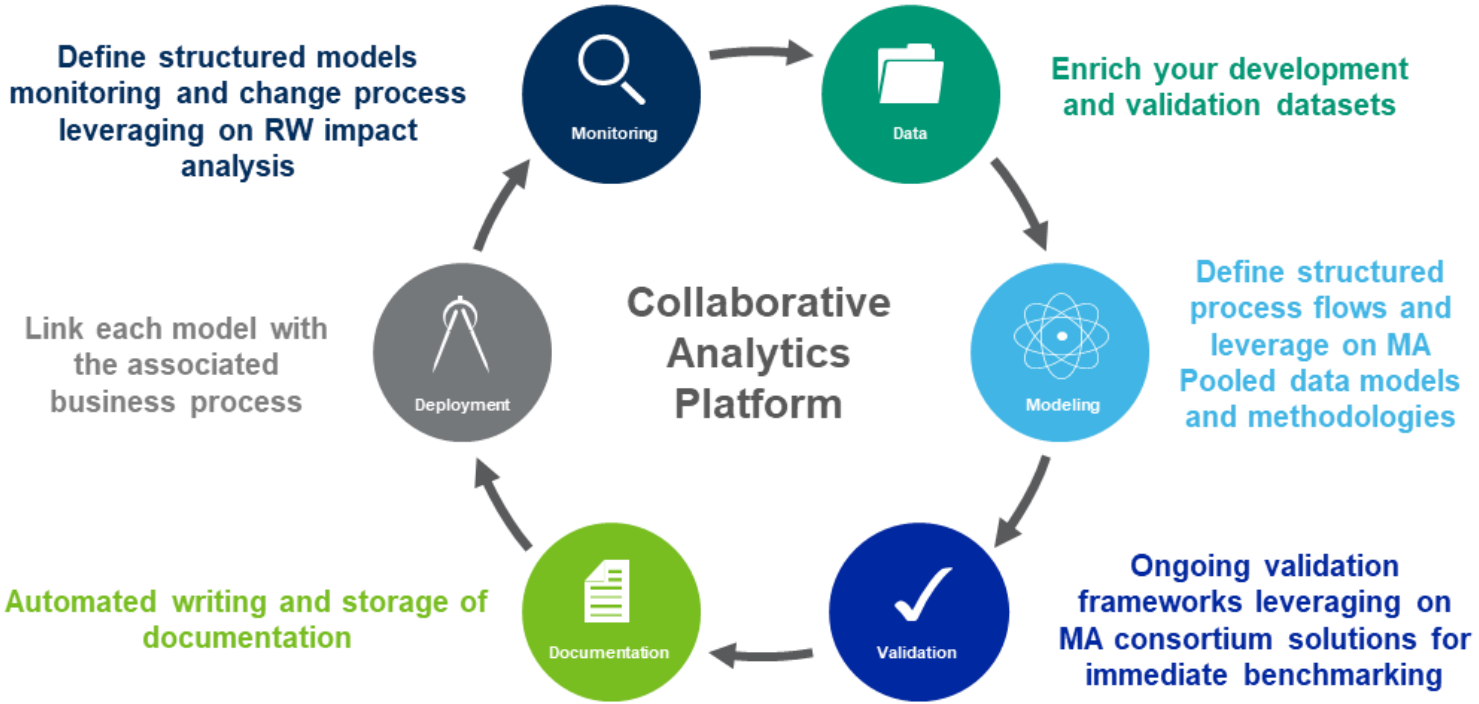
Model Management

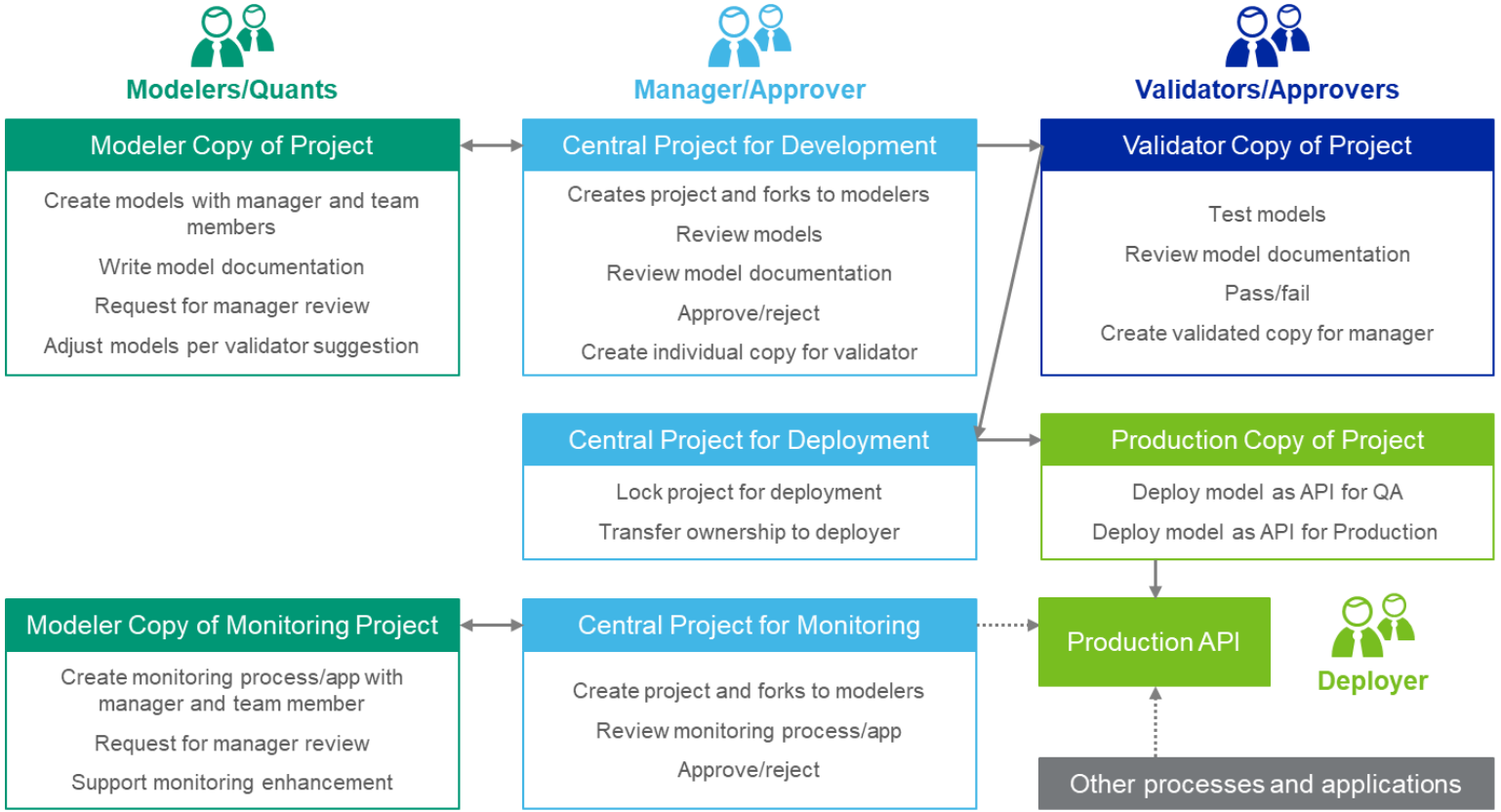
Process – Manage the models lifecycle & data

Robust data architecture and integrated platforms



CAP - Process and User Roles Overview

Fully customizable to fit user's own phases



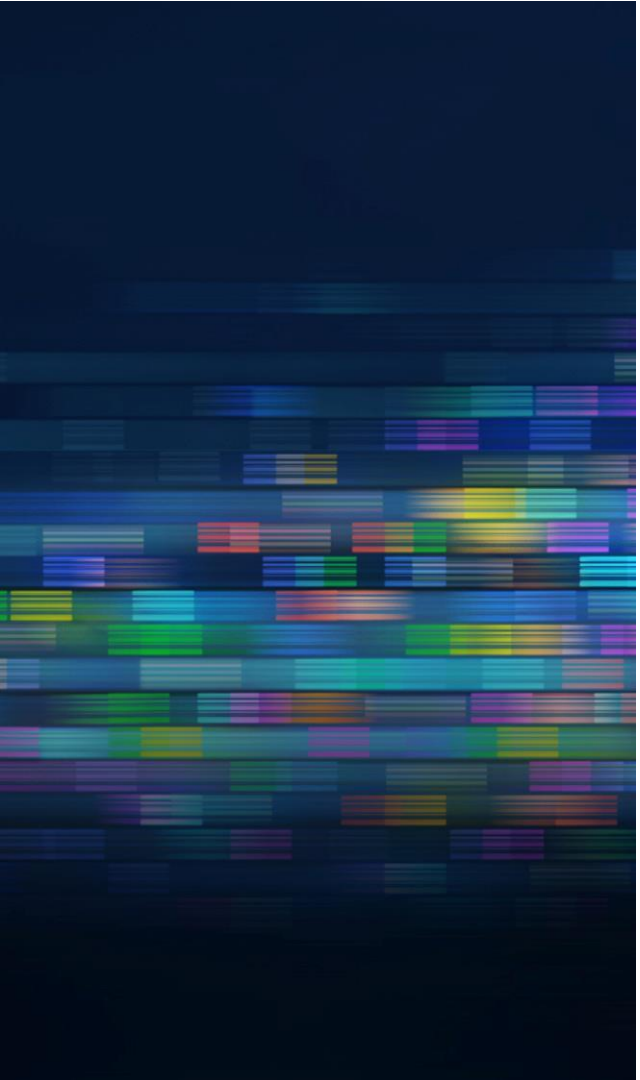
Moody's Collaborative Analytics Platform & App Offering

The Challenge: Effectively Conducting Model Risk Management

- Banks and non-banking financial institutions model risk management often **rely on multiple systems**, separate excel, SAS or R / Python codes and model documentation spread out across many different teams
- Many of these processes are **labor intensive** and rely on knowledge of the specific individuals
- **Traceability** often becomes a problem as systems for handling datasets and modelling decisions are often missing or spread across multiple divisions
- New developments or changes to existing models require a **long project execution timeline** and considerable effort for implementation/testing

The Solution: A workflow and mass scale approach to Model Risk Management

- **Ensures traceability** by allowing users to store data and modelling decisions from data quality to chosen factors and final model
- Combines internal and external data in a seamless way.
- Allows the users **to see results in real time** with the option of writing **automatic reports** in your chosen format (pdf, word, pptx etc).
- By using our cloud based computing power, you can run extensive modelling jobs with **increased efficiency**
- Final models can **be released via API's** and placed into the CAP model inventory becoming "production ready"



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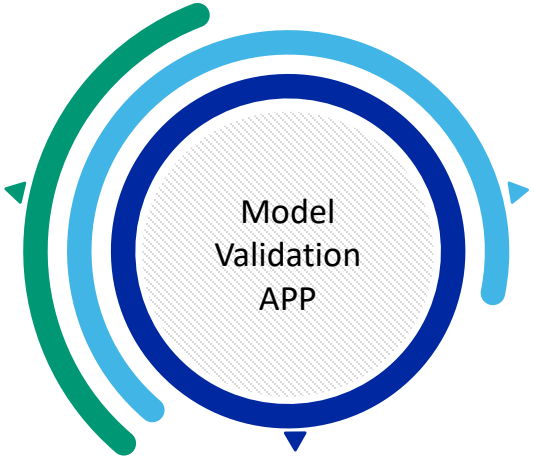
Model Validation

Model Validation App

Client Portfolio Data, Rating to PD Mapping

- Historical Portfolio Data
- Challenger Model PD (or RiskCalc Input for client portfolio)
- Rating to PD Mapping Master scale
- Model Score Structure (if available)



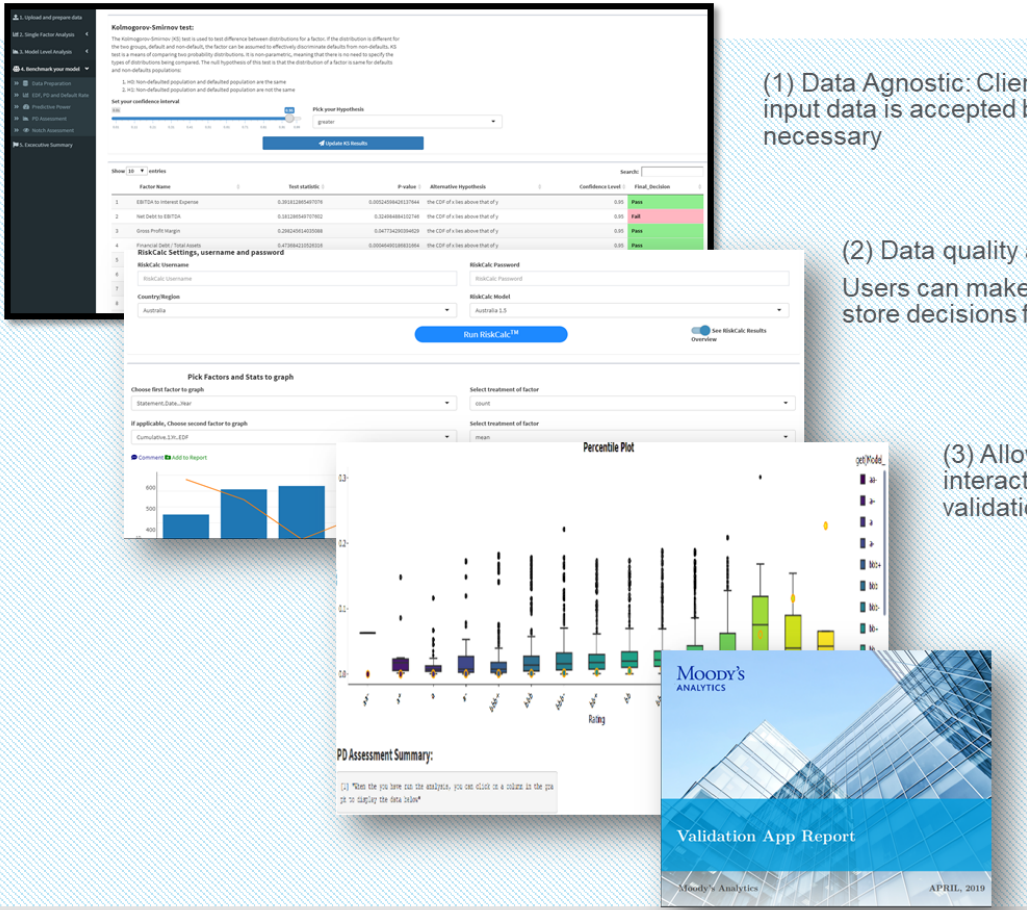
Model Validation

- Data Quality and Preparation
- Single Factor Analysis
- Model Level analysis (back-testing)
- Benchmarking – Option to run RiskCalc
- Automated Report Writing

Outputs

- Intermediate Data – After Data Cleaning
  - Data Cleaning Rules
  - Validation Decisions
- Automated Report (pptx, word, pdf)

Model Validation App: Program Features



(1) Data Agnostic: Client portfolio data and RiskCalc input data is accepted but no hard structure necessary

(2) Data quality and preparations:

Users can make data preparations and store decisions for later use

(3) Allows user to drill into results through interactive graphs and a multitude of validation analysis options

(4) Intermediate output exports to Excel, final output exports to PPT and Word and pdf incorporating real-time user commentary

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Moody's CreditLens

Next Generation Credit Assessment & Origination Architecture

Waseem Nisar, Solutions Specialist

March, 2021

Agenda

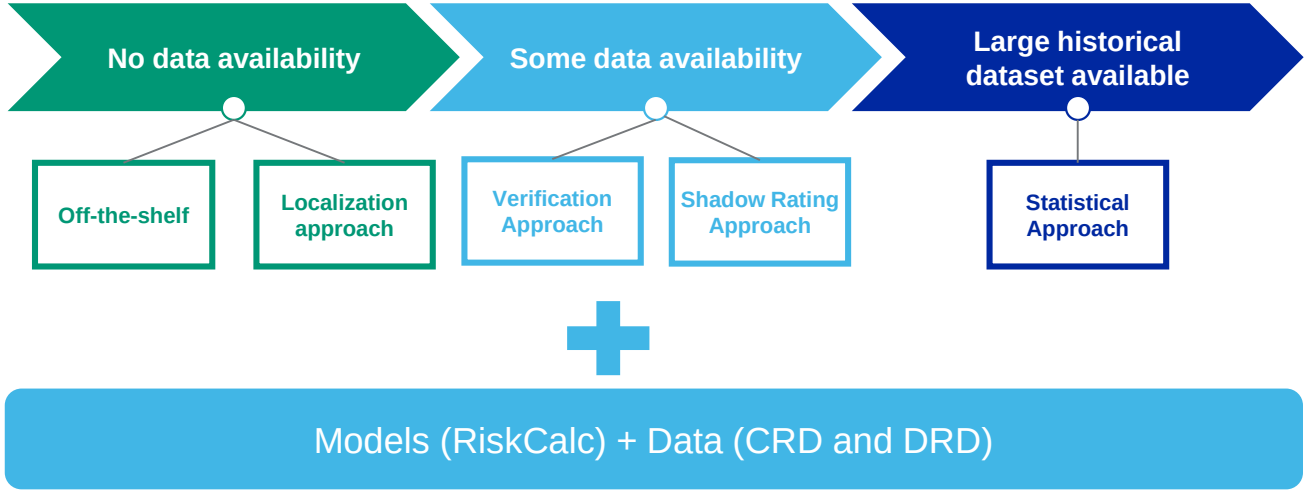
1. Why is a Credit Risk Rating Solution required?
2. CAP™ for Model Lifecycle Management
3. CreditLens™ as a Credit Risk Rating solution
4. CreditLens Demonstration

1

Why is a Credit Risk Rating Solution required?

Challenges: PD modelling approach

The approach to PD modelling depends on the amount of existing data in the organization's respective portfolio:



Data Availability: The two key elements are number of obligors and number of defaults in the past (for example over the last 5 years) per relevant portfolio.

IRB Accelerator : The use of an off the shelf model as for Example RiskCalc as the starting point can reduce the Development Timelines and increase the statistical robustness of the final model

Challenges: Banking

Why is a Credit Risk Rating solution required?

Benefit from the investment made on developing rating models

LEVERAGE INVESTMENT

Leverage the investment to develop rating models

Reduced the cost of operations

Outputs from the model helping make better informed credit decisions

OPERATIONAL EFFICIENCY

Reduce the need for manual processes

Central system

All the data in one place

Reduce cost for rating customers

RISK & REGULATOR

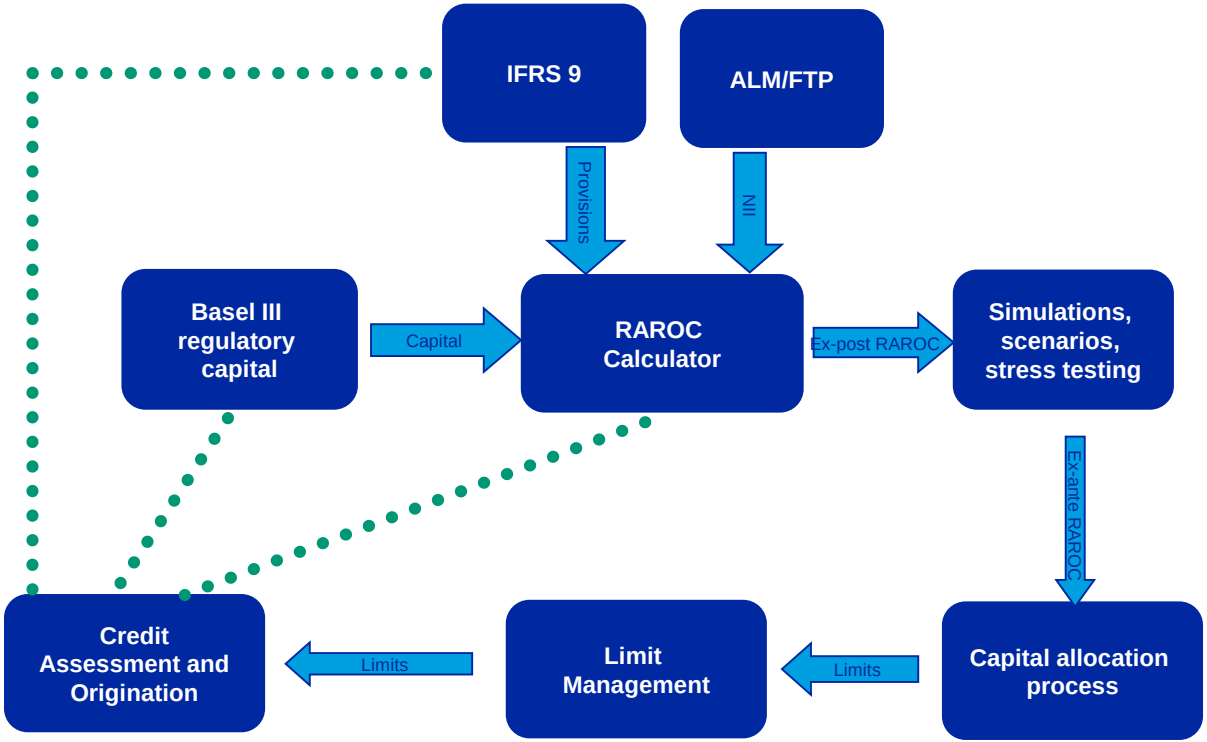
Active Risk Monitoring

Consistent, Quality Data

Accurate Risk Assessment

Robust Risk Control

Impacts the whole bank - The Virtuous Cycle



2

CAP for Model Lifecycle Management

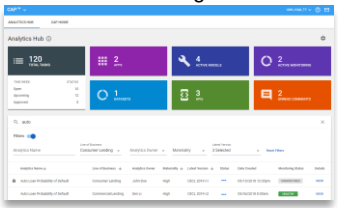
Collaborative Analytics Platform (CAP)

A centralized model development, validation and deployment platform for orchestration of model execution and easy deployment to Moody's application in a well governed and efficient manner

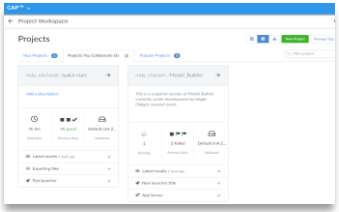
SUPPORT FOR

- ☑ Model development in R, SAS, Python and other open source languages
- ☑ Model development workflow for individual and systems of models
- ☑ Model inventory dashboard and tracking
- ☑ Full model documentation repository
- ☑ Central model monitoring application
- ☑ API to deploy models via restful calls

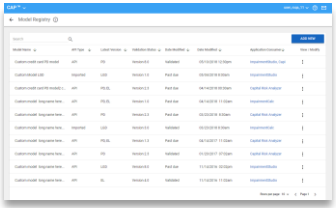
Model inventory dashboard and tracking



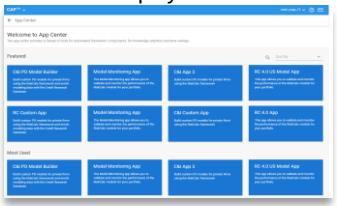
Project workspace tracking all model artifacts and allows for testing and benchmarking as well as validation



Model registry to deploy model via API and control for versioning of prod models



App Center to access Moody's data, modeling frameworks and monitoring processes for end users and deployment



3

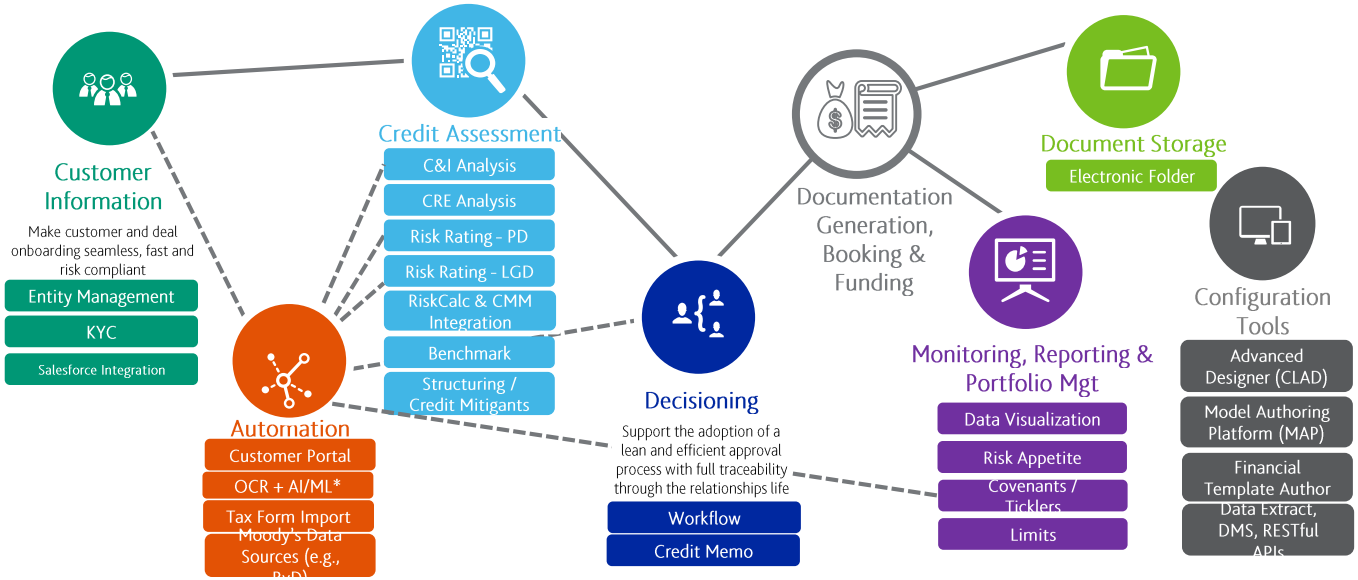
CreditLens for Credit Risk Solution

Relevance for this Region : it’s all there !

Let Bankers Do More Banking with CreditLens

Engineered for Modularity

Modular for use in whole or part across the lifecycle of the loan



Analytics

Powerful financial analysis and risk grading developed over 30 years

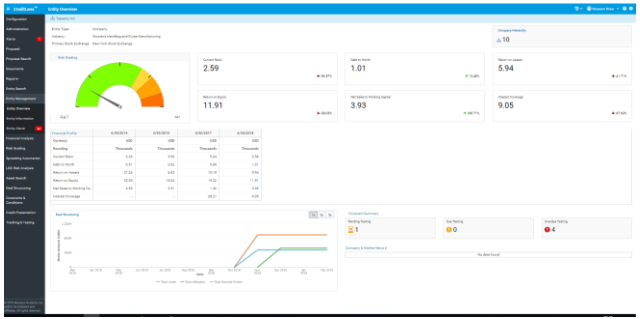
- Probability of Default and Loss Given Default measures
- Industry standard and custom ratio analysis
- Multiple accounting templates available to support regional and industry specific accounting standards
- Integration with our 30 industry and regional specific market leading RiskCalc models, which leverage the largest global database of private company financial information
- Integration with internal, regulator approved models, or statistical platforms such as ‘R’

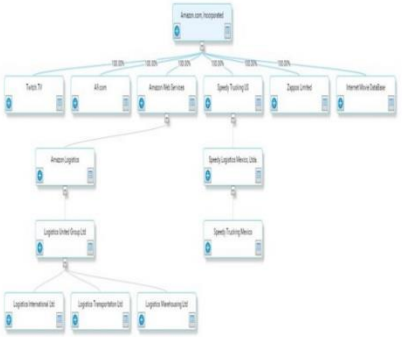
Deeper insight and control of the entire relationship

Provides a consistent and complete view for risk assessment

Entity Management

- Dedicated entity management module provides core building block
- Provides an overview of how the entity is performing
- Construct relationship structures pivotol to accurate risk assessment
- Tune and validate data capture in accordance with entity type – improving data strength and quality
- Control and distribute risk grades within a relationship

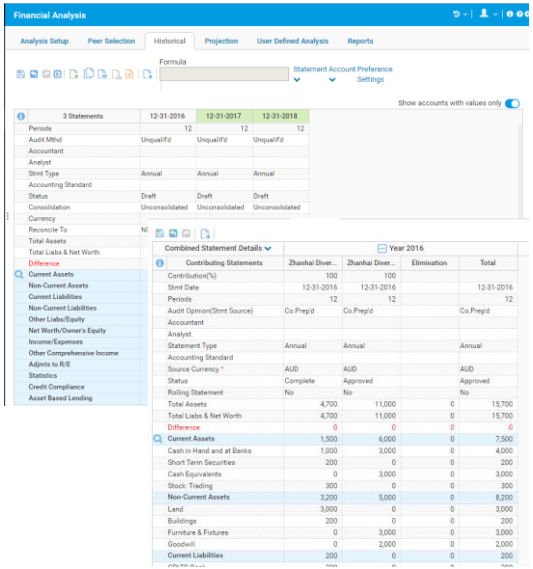




Deeper, efficient spreading designed for speed

Financial Analysis

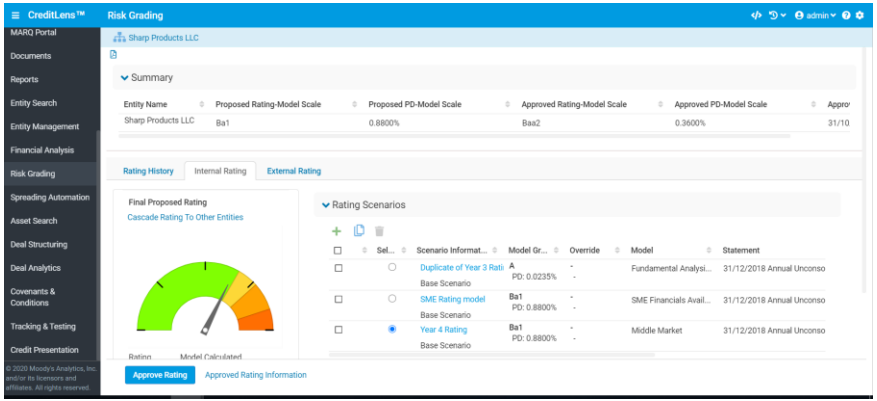
- Capture finanacial information in multiple formats by industry or accounting standards
- Automated spreading using OCR and machine learning technology
- Spreading grid HTML based with excel feel
- Ability to create projections using the historical finanacial statements
- Easy to use (copy/paste, undo/redo, search, etc.)
- Combine accounts from multiple entities
- Hard-lock statements
- Show accounts with values only
- Statement level currency
- Automated duplicate checking
- Standard out of the box reports – Financial, Peer Comparison, Consultant, Projection



In-depth assessment of borrower health

Risk Grading

- Out of the box rating models (SME's, Middle Market, Corporates, etc.)
- Hierarchical grade distribution
- Configurable automated model selection
- Support for multiple scenario's including what-if for stress assessment
- Extended override classifications
- Optional business process management control
- Model as Service - 'R' Integration



4

CreditLens Demonstration

Waseem Nisar
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