Assessing Model Risk with Effective Validation

Olga Loiseau-Aslanidi , PhD
Director
Business Analytics

Anamaria Pieschacon, PhD
Director
Model Validation

Petr Zemcik, PhD
Senior Director
Economics & Business Analytics

May 20, 2020

Moody's Analytics operates independently of the credit ratings activities of Moody's Investors Service. We do not comment on credit ratings or potential rating changes, and no opinion or analysis you hear during this presentation can be assumed to reflect those of the ratings agency.

Presenters

Olga Loiseau-Aslanidi PhD, Director
Head of APAC Risk Modelling
Economics & Business Analytics | Singapore

Anamaria Pieschacon PhD, Director
Global Head of Model Validation
Economics & Business Analytics | USA

Petr Zemcik PhD, Senior Director
Head of EMEA Risk and Economics
Economics & Business Analytics | UK

Agenda

1. Model Risk in Spotlight
2. Effective Model Validation
3. Application to IFRS 9 Model
4. Key Takeaways

1 | Model Risk in Spotlight

Institutions Rely on Models to Guide Decisions

Manage risk, identify opportunities and comply with regulation

Scenario Generation
Stress Testing
Reverse Stress Testing
IFRS 9 Impairment Modeling
ICAAP with IRRBB
Credit Risk Concentration
Economic and Regulatory Capital

Collection Scorecard
Optimal Workout
Credit Policies
Roll Rate Analysis
Tracking Collectors Efficiency

Application Scorecards
Credit Policies
Risk Based Limit Management and Pricing
Risk and Profitability Based Decisioning
Credit Line Assignment
Risk Appetite Framework

Behavioral Scorecard
Credit Transition Matrix
Credit Line Management
Fraud Detection
Loss Forecasting
Scenario Generation
Stress Testing
Early Warning Indicators
Propensity and Churn Modeling

COVID-19 Calls for Model Revision

Mitigating model risk is a basis for effective crisis management

Understand → **Identify** → **Enhance** → **Act**

Understand

Changes in Market Conditions

- Beware of potential model failures and model interdependencies
- Quantify what COVID-19 means for the economy
- Generate multiple future paths to revise existing adverse scenarios

Identify

Affected Models in Scope

- Which models I should be most worried about?
- Which aspects of models are most affected?
- Credit risk and liquidity risk models are most vulnerable

Enhance

Validation and Benchmarking

- Assess models' stability and validity
- Timely and consistent model adjustments such as recalibration using most recent data, overlays
- Incorporate regulators' mitigating actions
- Enhance model monitoring

Act

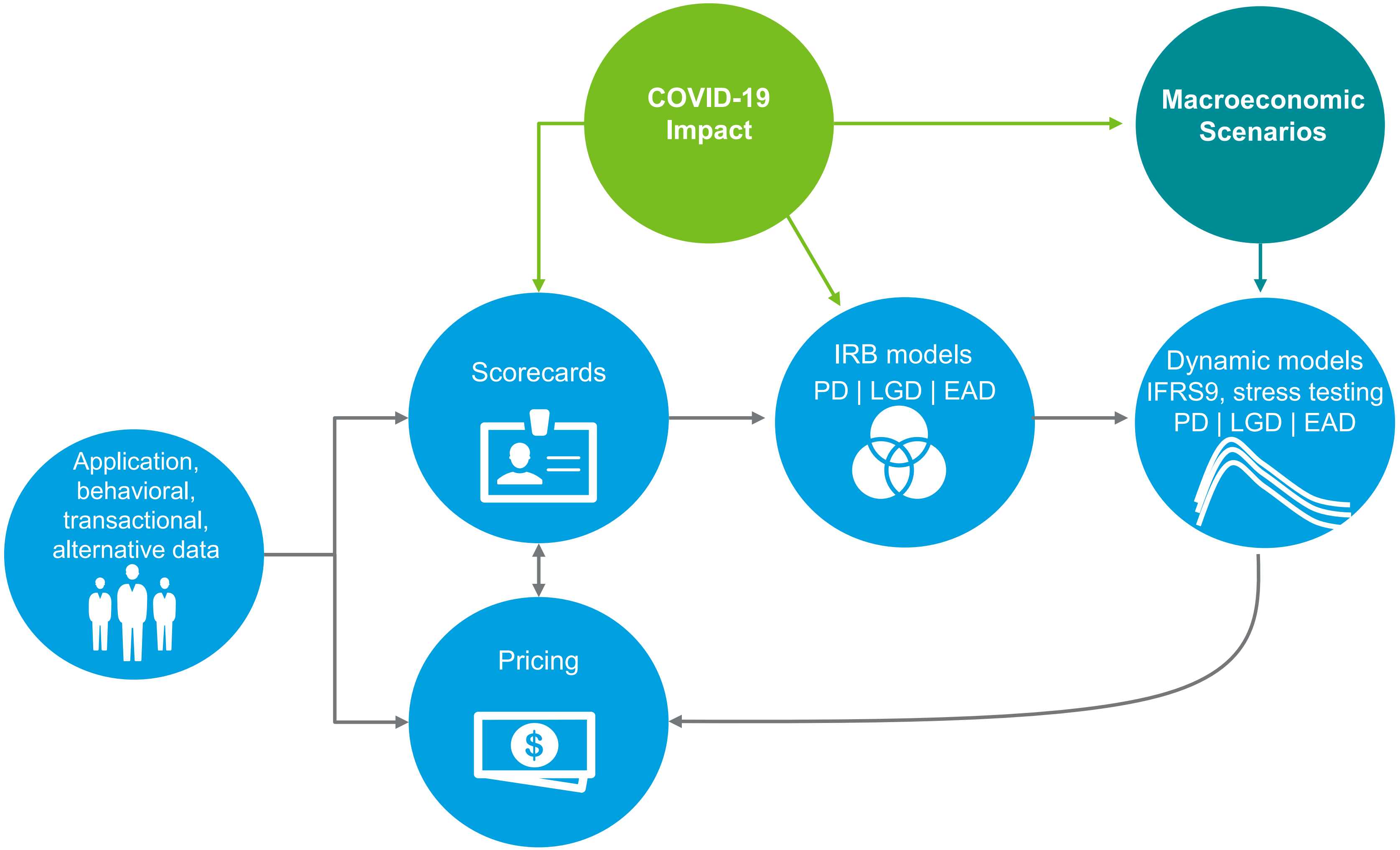
Portfolio Management

- Identify most vulnerable exposures
- Planning for vulnerable exposures and portfolios under stress
- Optimize capital allocation

Proactive Overhaul of Model Risk Management

Credit Risk Models Are Among Most Vulnerable

Need to improve model resilience during pandemic and beyond



2

Effective Model Validation

Robust Model Governance as a Precondition for Effective Model Risk Management

More Models

Greater Model Complexity

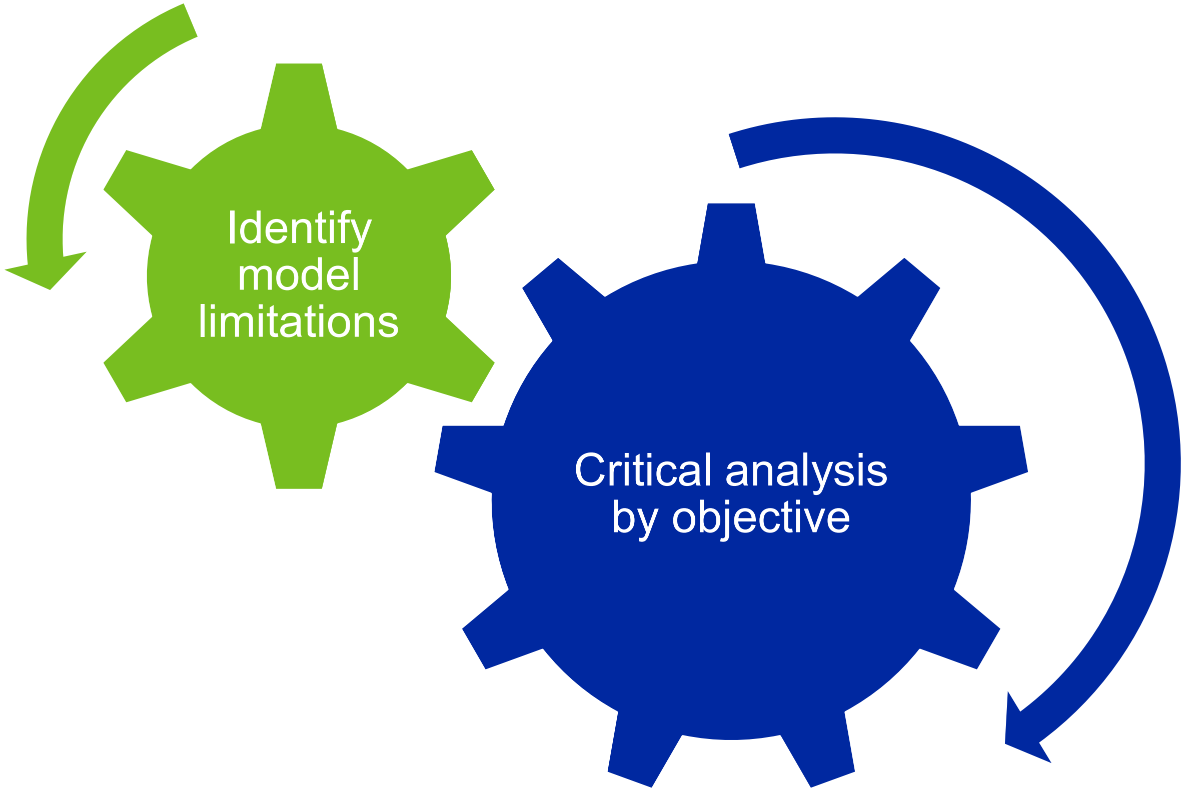
Significant Financial Impact

Increased Data Availability

Amplified Supervision

Effective Model Validation

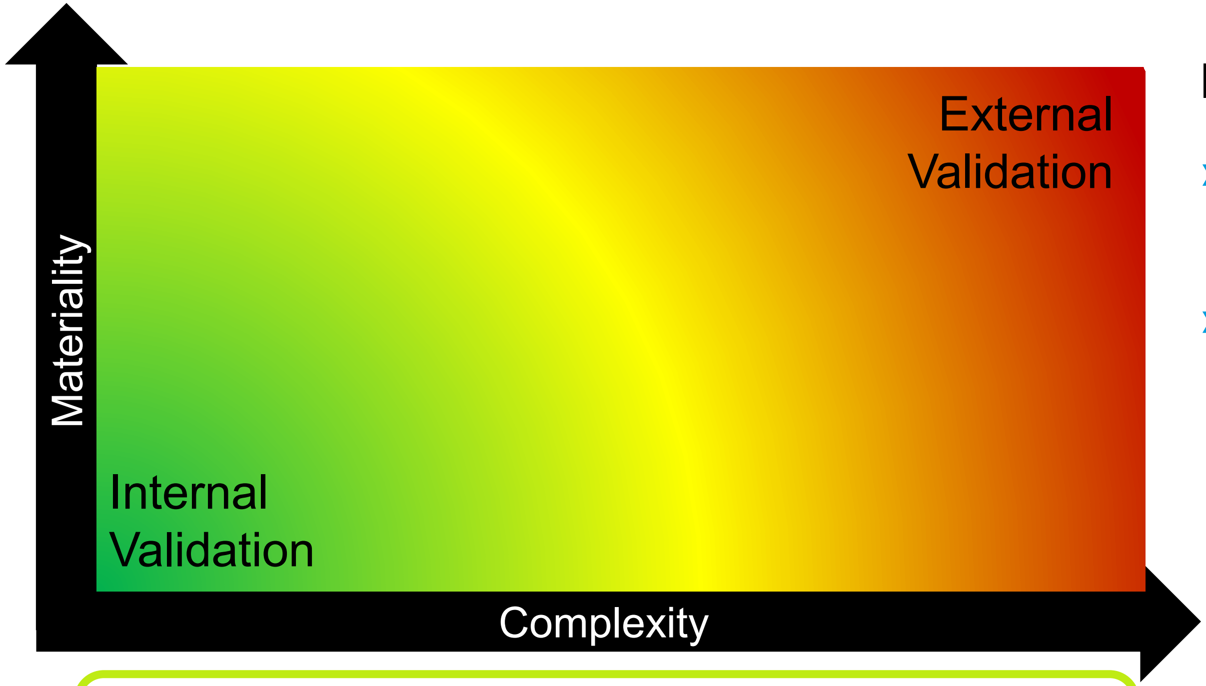
Managing Model Risk Involves Effective Challenge of Models



Effectiveness depends on a combination of incentives, competence, and influence

Depth of Validation

Intensity should be proportional to the materiality of the portfolio



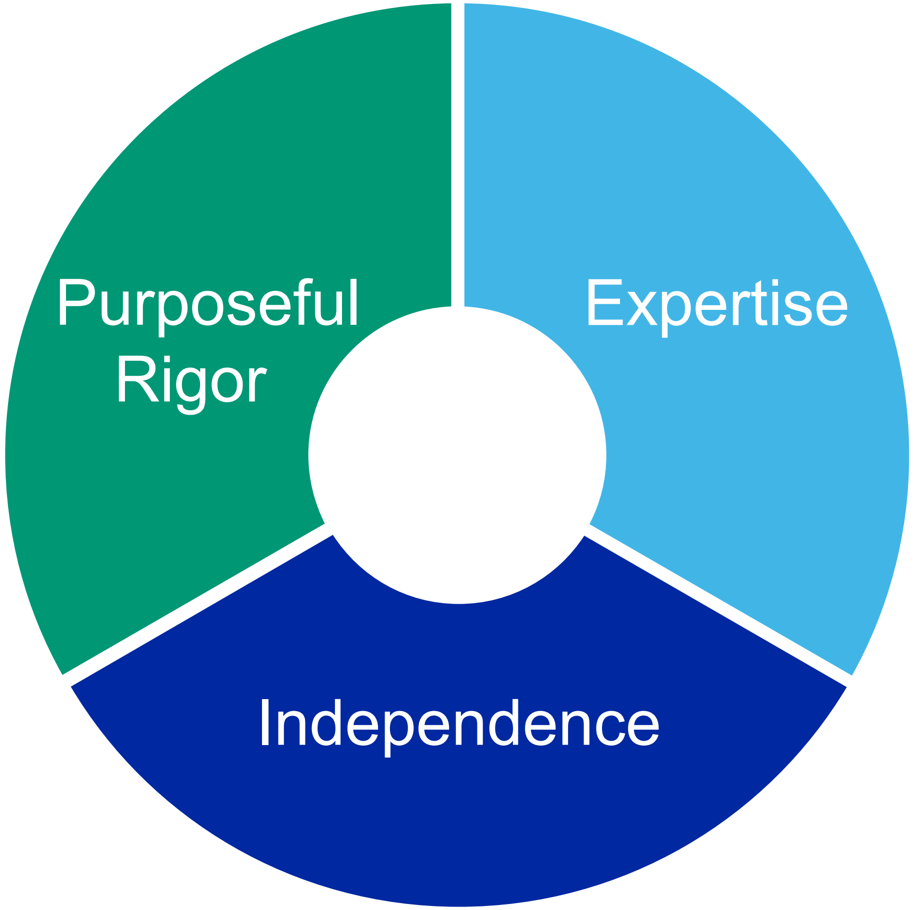
MRM team can hire external validation
if they lack in-house expertise

In all cases,

» MRM team should establish model performance thresholds for periodic monitoring.

» MRM team should run periodic performance tests and perform formal annual validation.

3 Pillars for Effective Model Validation



Expertise & Purposeful Rigor

Loan Lifecycle Management Models

Application, Pricing, Origination, Monitoring, Loss Mitigation, Disposition

Other Advisory Services

Gap Analysis, Best Practices and Model Governance

Business & Strategic Planning Models

Credit Policy, Marketing, etc.

Regulatory Capital & Stress Testing Models

Basel, CCAR, PRA, EBA etc.

Financial Reporting

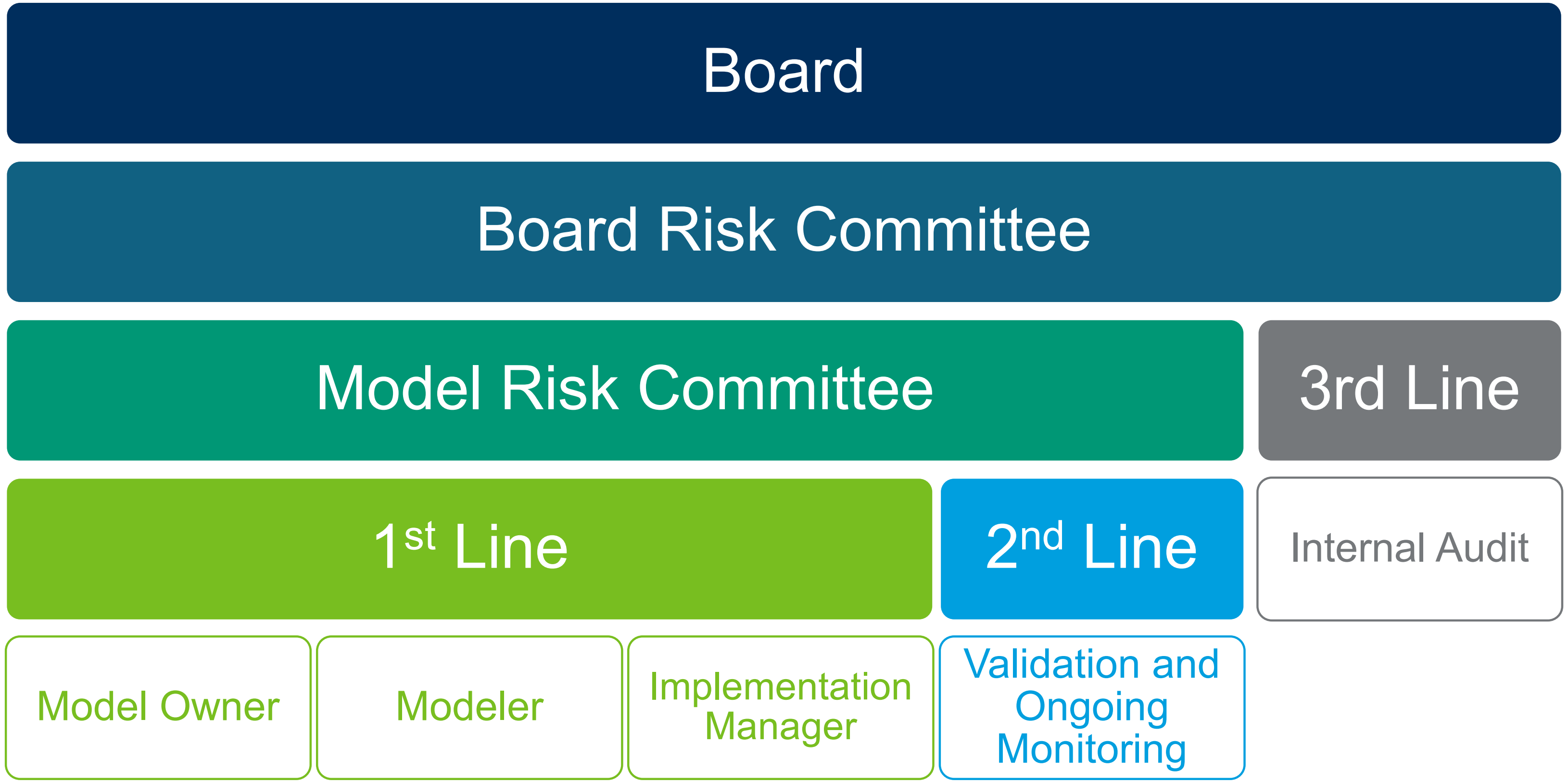
IFRS 9 and CECL

Credit Portfolio Management Models

Risk Appetite, Concentration Risk, Counterparty, Operational, etc.

Independence

- **Model developers and owners** should coordinate all stages of model lifecycle, including implementation.
- **Validators** should provide effective challenge to existing models, based on purpose and materiality.
- To avoid conflicts of interest, validation should be performed by a team independent from model development.



Our Validation Process

Qualitative

Evaluation of conceptual soundness

Validation Report

Assessment based on the qualitative, quantitative and benchmarking analysis

Quantitative

Replication and outcomes analysis

Benchmarking

Comparison of inputs and outputs of estimates from alternatives allows to assess and manage model risk

Model Evaluation – Action Ratings

Satisfactory

The model has no critical findings and is suitable for deployment.

Satisfactory with Recommendations

The model's performance is satisfactory and is suitable for deployment. Nevertheless, the validators have identified areas where the model could undergo improvements that may improve its overall performance.

Needs Improvement

The validators have identified multiple critical findings that have a negative impact on the model's performance. The current model provides at least a minimally adequate level of performance and can be used in its present form.

Unsatisfactory

There are important flaws in the model's underlying data, conceptual framework, or development process. Either i) the model cannot perform its intended function and should not be used in any decision-making capacity, or ii) there is not enough evidence to show that the model can perform its intended function and it should not be used in any decision-making capacity until such evidence becomes available.

Final Assessment: Model Ratings by Category

Issues Identified and Recommended Actions – Generic Example

Overall Rating

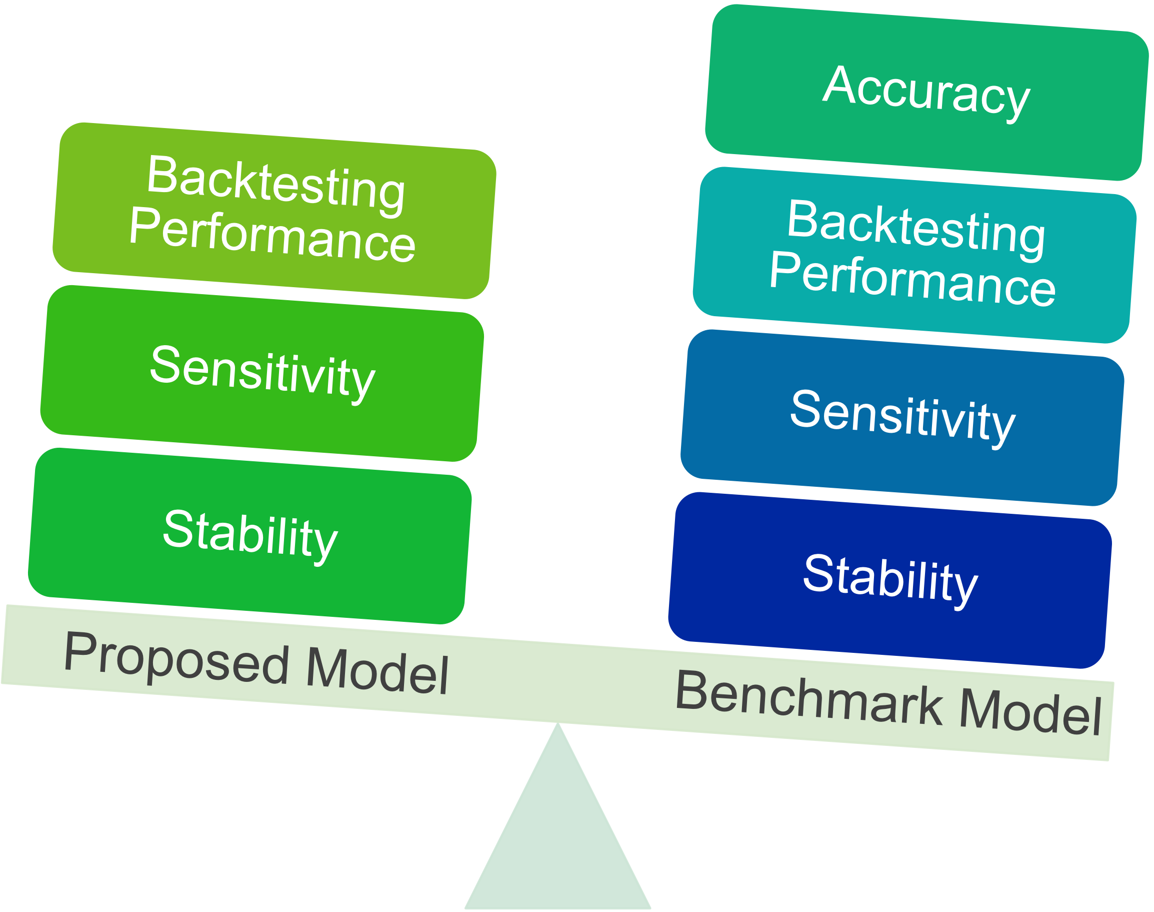
Risk Category	Rating	Comments
Documentation		The documentation needs to include XYZ.
Data Cleaning and Treatments		…
Variable Selection Process		…
Model Selection		…
Model Performance		…
Sensitivity Analysis		
Model Replication		…
Monitoring and Performance Tracking		…

The report will explicitly describe that the above risk categories do not hold equal weighting. The categories shown may not reflect actual categories used.

Our Validation Process

	01 Preliminary Model Review	02 Qualitative Validation	03 Quantitative Validation	04 Consolidation
COMPONENTS	Model document review/understanding Discussion with model owners/stakeholders	**Evaluate** » Purpose, scope, materiality » Model selection process » Data, conceptual soundness » Assumptions & limitations » Uncertainty & mitigating controls » Review model governance, ongoing monitoring/tests Identify and discuss any gaps with stakeholders	Replication In-sample and out-of-sample performance evaluation Stability and robustness Sensitivity Analysis Benchmarking*	Review and verify additional analysis submitted by model owners Document and categorize the findings by severity, issue recommendations Push documents and scripts to production
DELIVERABLES	Initial model assessment	» Qualitative commentary on possible model deficiencies, implementation errors » Categorize by severity and issue recommendations	» Independent analysis » Independent implementation » Commentary on identified shortcomings	» Final document with action ratings » Recommendations and summary of findings

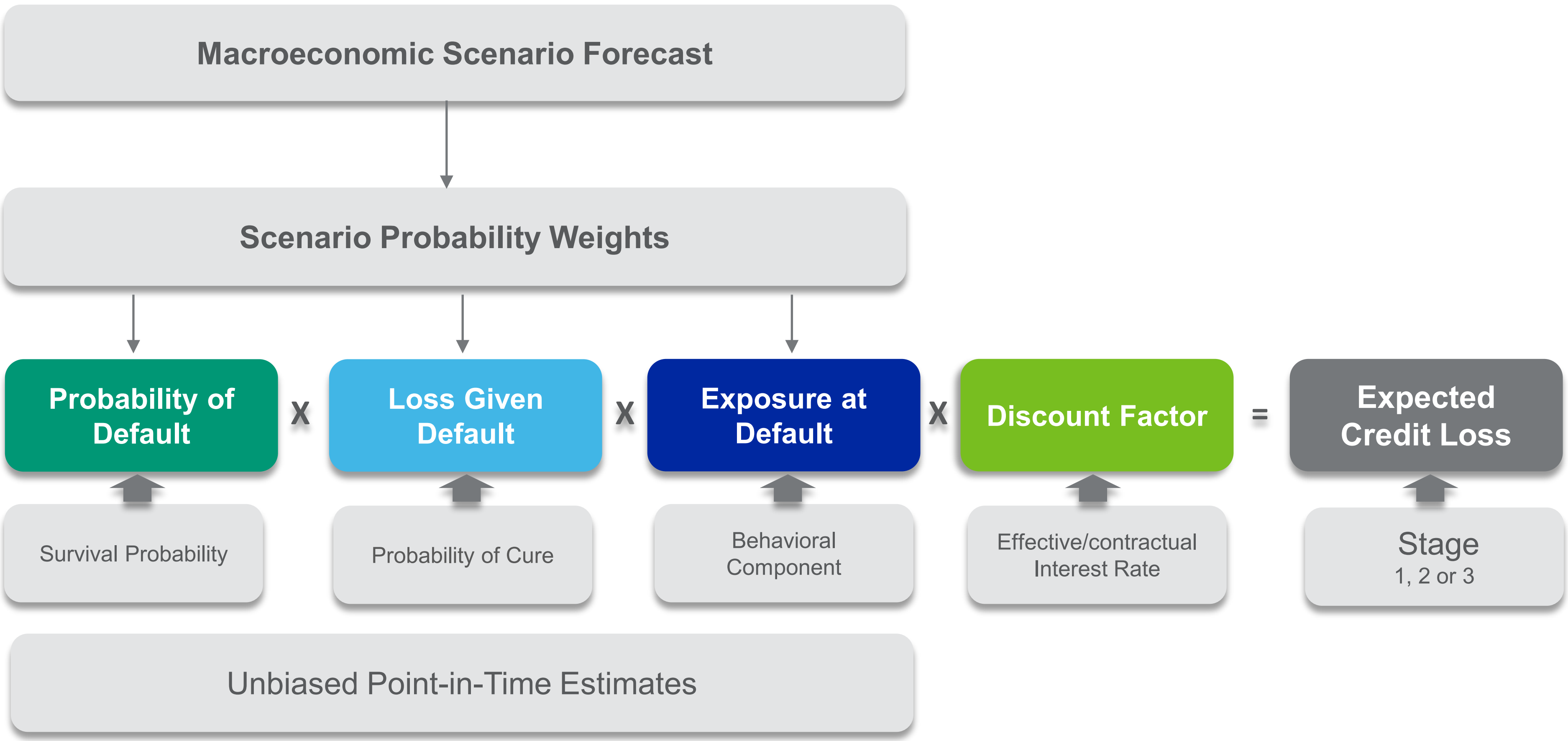
We Measure Model Risk by Benchmarking



3

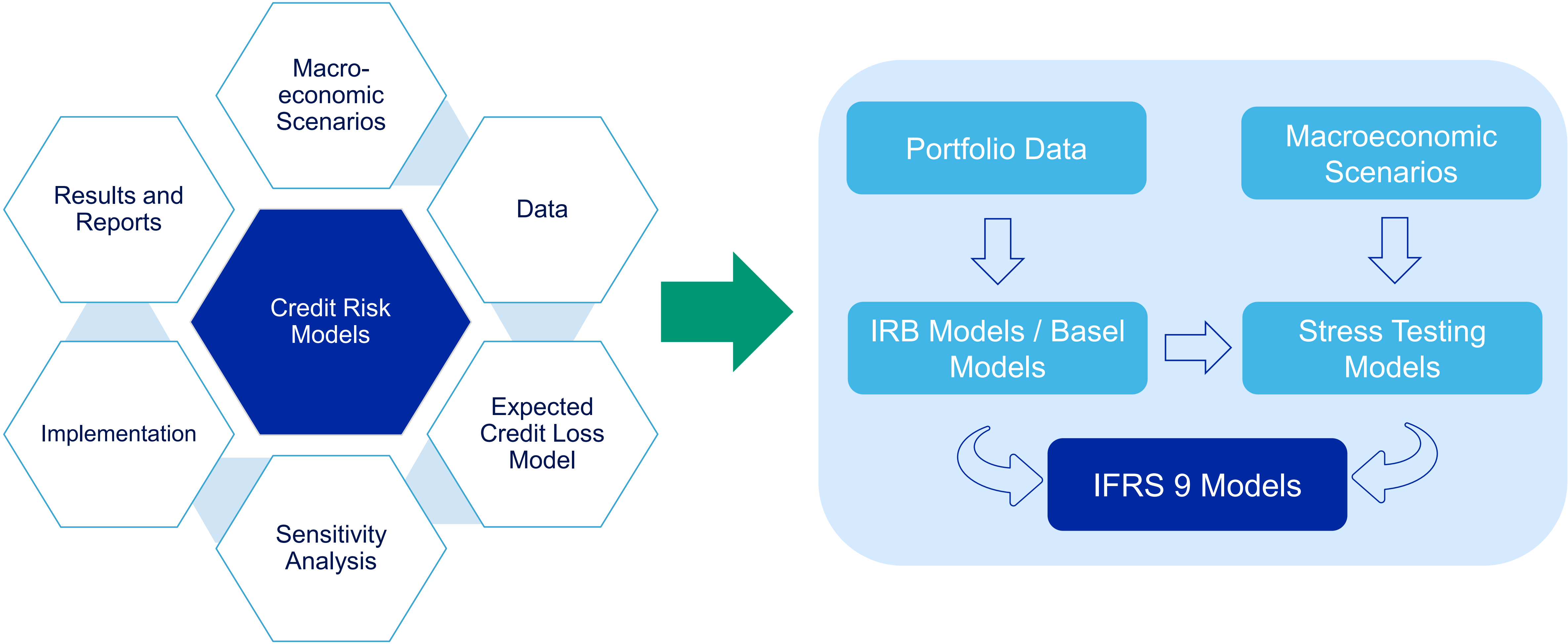
Application to IFRS 9 Models

Impairment Model

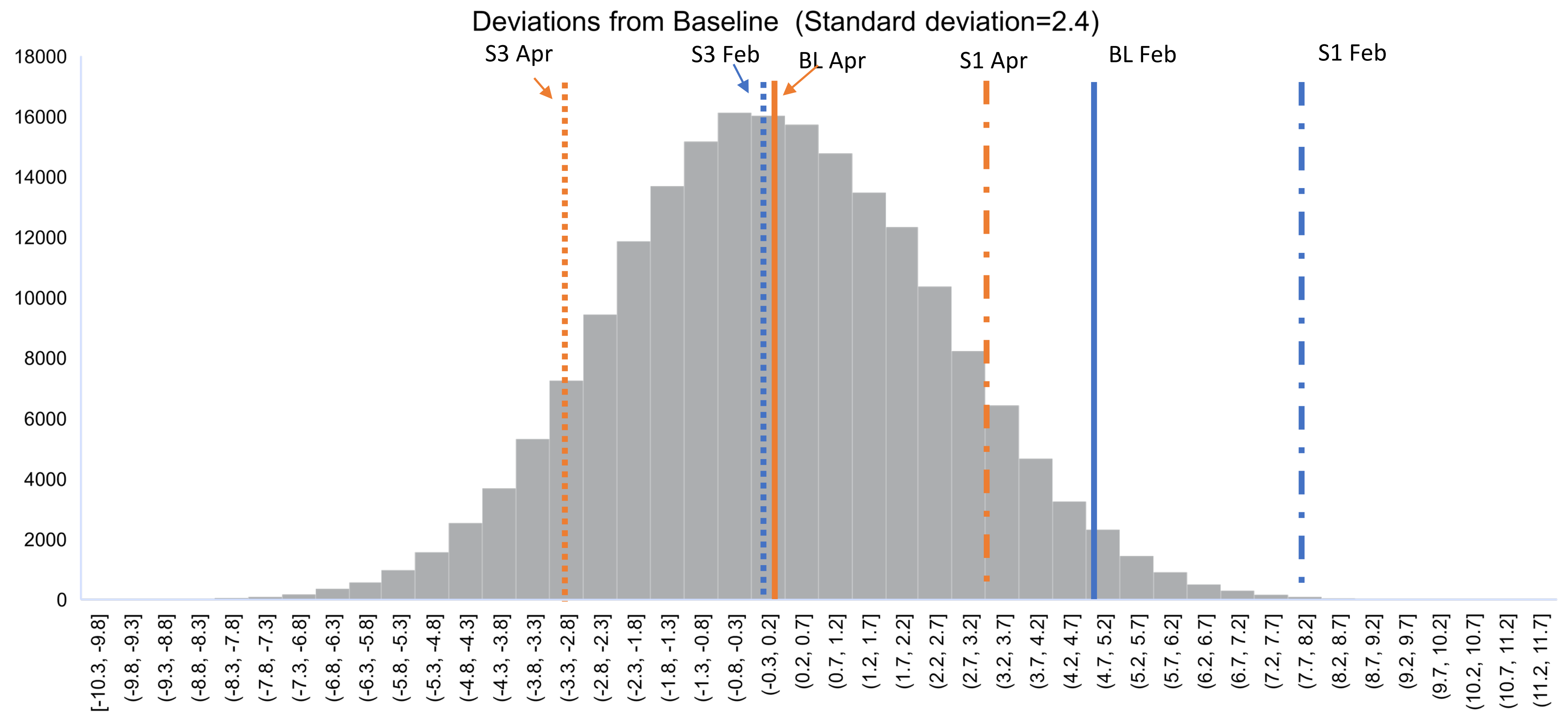


Credit Risk Models

An Integrated Process



Scenario Severity Shift



Source: Moody's Analytics

PD Modelling Approaches

Segment level

Modelling approach with three key factors influencing vintage segment performance:

PD= f

Lifecycle

Dynamic evolution of vintages as they mature

Quality of Vintage

Variable capturing the heterogeneity across cohorts: vintage dummies, portfolio characteristics and/or economic conditions at origination

Forward-looking Indicator

Sensitivity of performance to the evolution of macroeconomic and credit series

Account level

PD is forecasted using customer and loan characteristics, and macroeconomic indicators using panel data econometric techniques

PD= f

Customer and Loan Level Characteristics

Characteristics such as LTV, score, months on book, education, etc.

Select pre-macro model using single factor and multifactor analysis

Macroeconomic Drivers

Variable selection algorithm to select macroeconomic drivers.

Transition Matrix Approach

1. Segmentation

» Switch to bucketing based on DPD & LTV
» No further segmentation

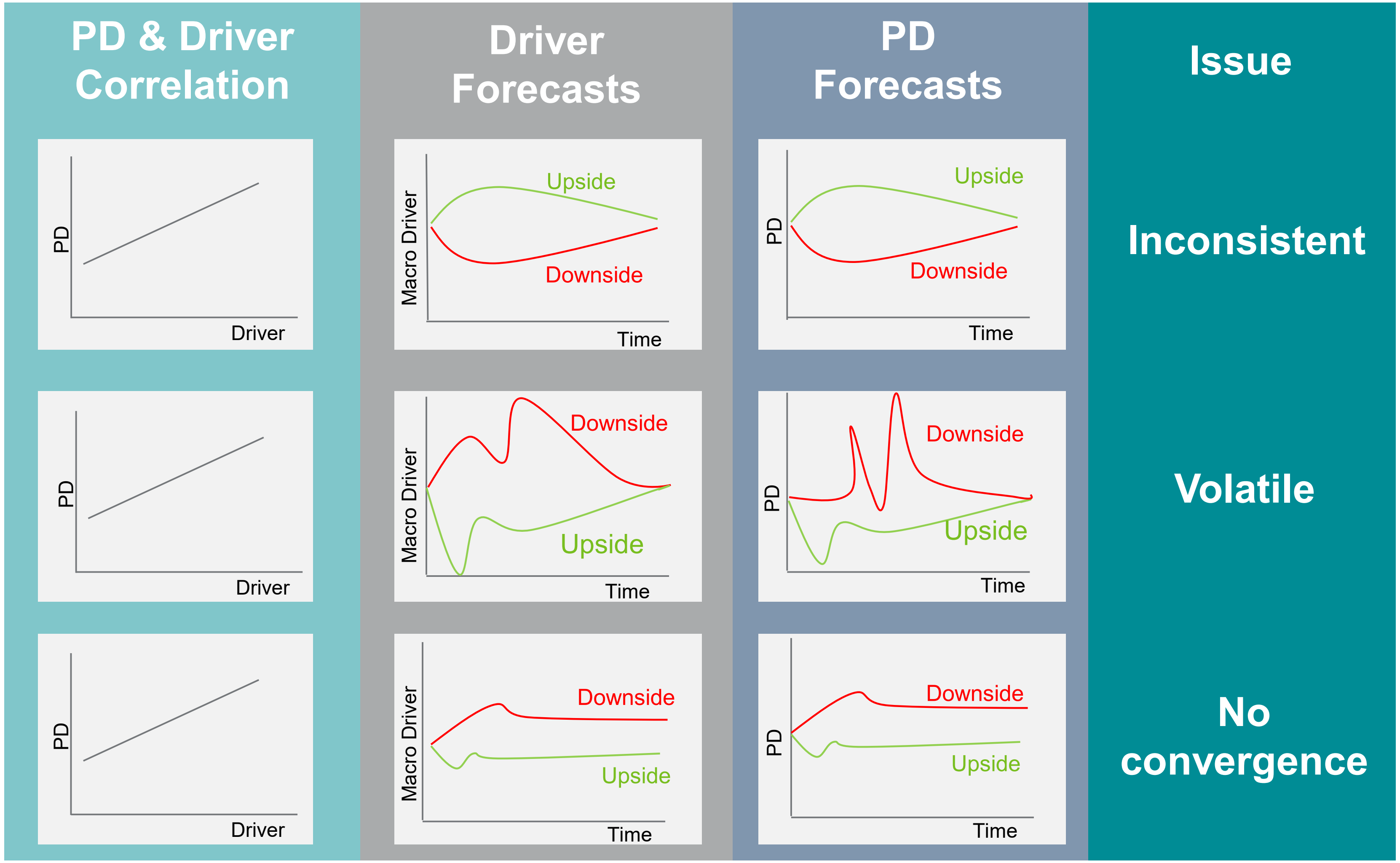
2. Data Inputs

» Internal portfolio
» Macro data

3. TTC Matrix Creation

» Initial estimation
» Smoothing
» Scaling

Looking at Forecast Properties



- Policy variables, e.g. CPI
- Changes in past correlations
- Non-cyclical sectors
- Growth rates:
  - Low range level variables, e.g. RMM
  - QoQ growth rate
- Long-term forecast property of transformation

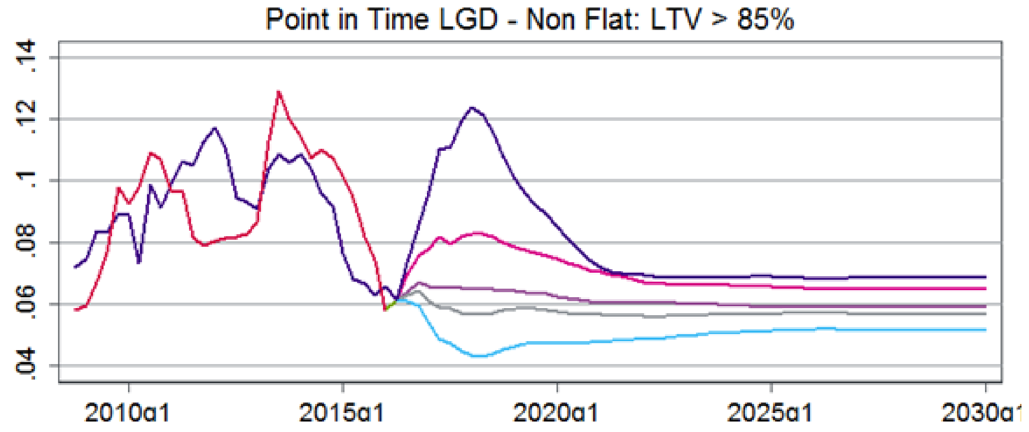
LGD Design Approaches

Balance and Recoveries

For a facility i, time t and workout period w:

$$LGD_i = 1 - \frac{balance_{i,t} - balance_{i,t+w}}{balance_{i,t}}$$

Default Vintages & Macro Drivers



By Assumption

LGD of 50-60% for PF, 30-40% for RE and 65-75% for CC; fully insured products usually get LGD of 5-10%.

Estimates of recovery costs range from 1-2%.

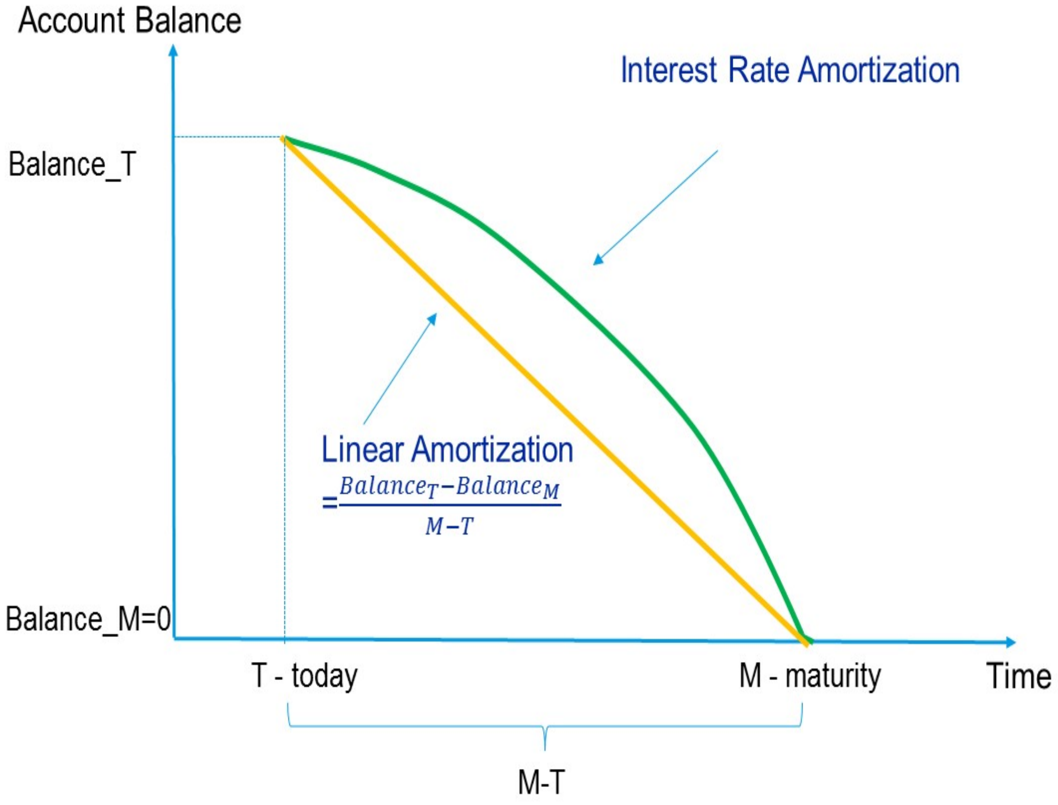
Roll Rate Modelling

$$RR_{it} = 1 - LGD_{it}$$

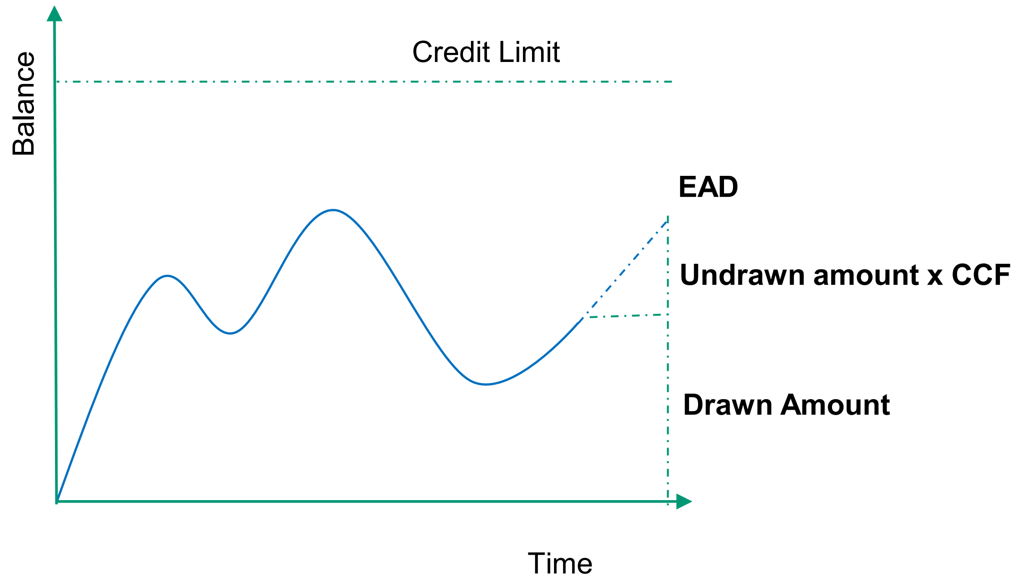
		0	1	2	3	4	5	6	7	8	9	10	11	12
	Cycle 0													
	Cycle 1													
Performing	Cycle 2	0.00%	4.73%	5.95%	6.70%	7.23%	7.53%	7.59%	7.61%	7.63%	7.57%	7.63%	7.68%	7.79%
	Cycle 3													
	Cycle 4													
	Cycle 5													
Non - Performing	Cycle 6	100.00%	95.27%	94.05%	93.30%	92.77%	92.47%	92.41%	92.39%	92.37%	92.43%	92.37%	92.32%	92.21%
	Cycle 7													
	Denounced													

EAD Design Approaches

Fixed Term Products - Amortization



Revolving Products - CCF



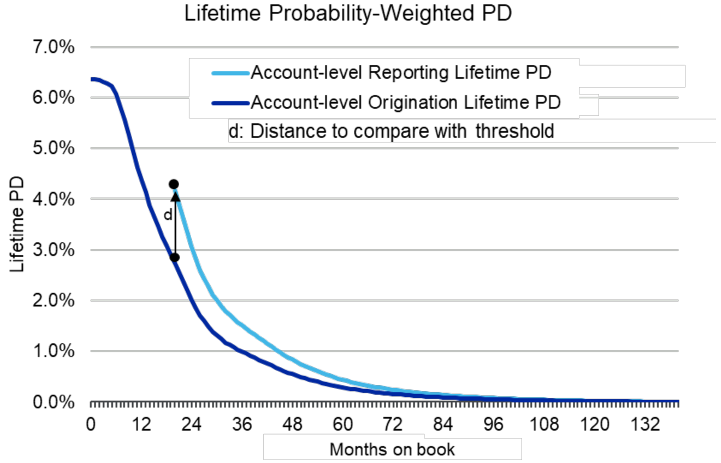
$$EAD_{i,t+h} = BAL_{i,t+h} + CCF * UNDRAWN_{i,t}$$

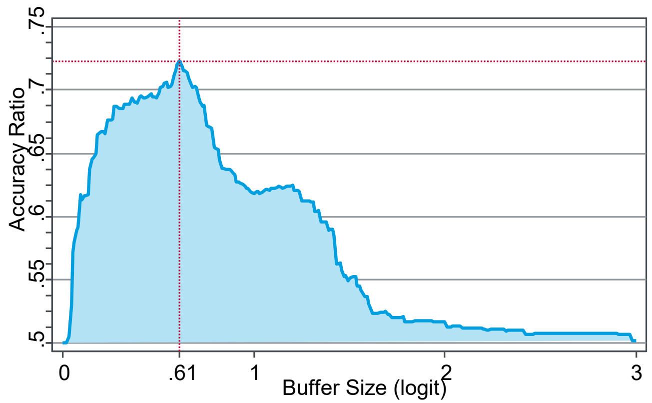
Evaluation of SICR

Quantitative Approach

Characteristics of the metric:

- Forward-looking (scenarios)
- Capture risk of default
- Lifetime information
- Available at origination and at reporting date





What is the optimal ***d*** to identify SICR?

- Buffer is the optimal value of ***d*** that maximizes an accuracy ratio from good:bad odds analysis
- We examine differences (in logit) between
  - the lifetime PD at the reporting date → Lifetime PD(T)
  - the lifetime PD at the same age as the reporting date forecasted at origination → Lifetime $PD_0(T)$

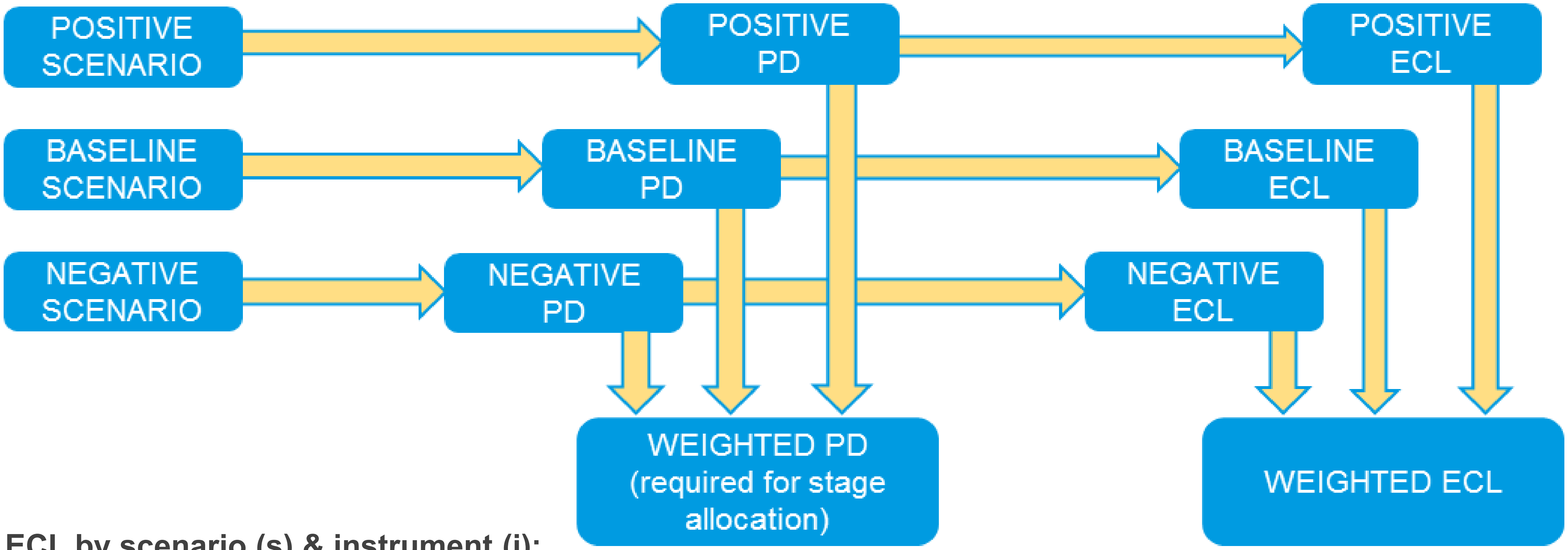
for different historical reporting dates

Status	Criteria	Stage
Non-Default	Lifetime PD(T) ≤ Lifetime $PD_0(T)$ + Buffer	1
Non-Default	Lifetime PD(T) > Lifetime $PD_0(T)$ + Buffer	2
Default		3

+ Qualitative Approach

- DPD
- Forbearance
- Watch list
- …

ECL Calculation



ECL by scenario (s) & instrument (i):

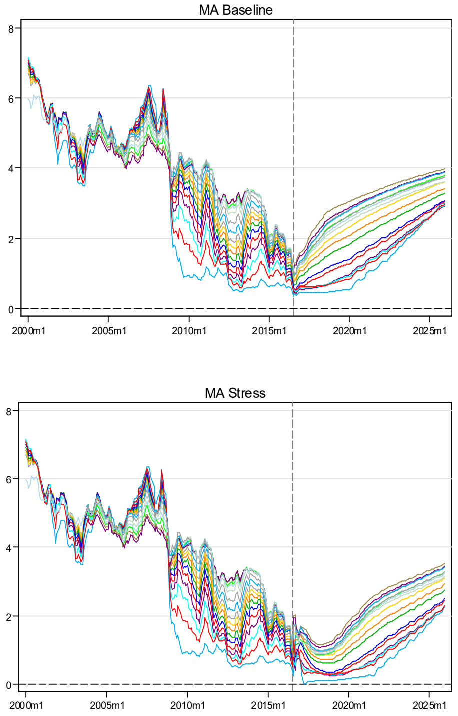
$$ECL(i|s) = \sum_{t} [PD(i,t|s) \ * \ LGD(i,t|s) * EAD\ (i,t|s) * DF\ (i,t|s)]$$

Probability-Weighted ECL by instrument:

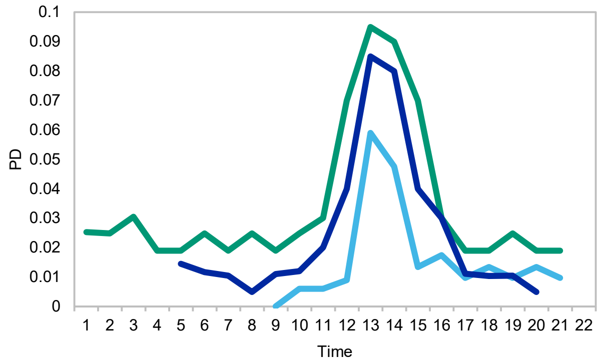
$$ECL(i) = p_1 ECL(i,|s_1) + p_2 ECL(i|s_2) + \ \ldots + p_S ECL(i|s_S)$$

IFRS 9 Validation Process

Robustness & Sensitivity Analysis



Portfolio Behavior to Changing Macroeconomic Conditions



Report

Qualitative — Quantitative — Final Assessment

- ✓ Methodology
- ✓ Data use, description & treatment
- ✓ Regulatory compliance
- ✓ Model governance

- ✓ Data analysis
- ✓ Model replication
- ✓ Model performance
- ✓ Benchmark model development

- ✓ Written report
- ✓ Observation, findings and recommendations and or remedial actions

IFRS 9 Case Study – Impact of COVID-19

Baseline Feb 2020

IFRS 9 Stage	#	%	Exposure	ECL=0.03
1	92,090	99.00	8,275,327,246	0.00
2	717	0.83	69,352,356	0.89
3	146	0.17	13,986,747	12.21

Baseline Apr 2020

IFRS 9 Stage	#	%	Exposure	ECL=0.05
1	92,047	98.90	8,266,730,875	0.01
2	760	0.93	77,948,726	1.68
3	146	0.17	13,986,747	12.82

Upside Feb 2020

IFRS 9 Stage	#	%	Exposure	ECL=0.03
1	92,093	99.01	8,275,597,498	0.00
2	714	0.83	69,082,104	0.79
3	146	0.17	13,986,747	12.21

Upside Apr 2020

IFRS 9 Stage	#	%	Exposure	ECL=0.04
1	92,082	98.99	8,273,841,624	0.01
2	725	0.85	70,837,977	1.31
3	146	0.17	13,986,747	12.82

Downside Feb 2020

IFRS 9 Stage	#	%	Exposure	ECL=0.04
1	92,079	98.97	8,272,959,874	0.01
2	728	0.86	71,719,727	1.35
3	146	0.17	13,986,747	12.21

Downside Apr 2020

IFRS 9 Stage	#	%	Exposure	ECL=0.07
1	91,770	98.34	8,219,603,740	0.02
2	1,037	1.50	125,075,861	1.88
3	146	0.17	13,986,747	12.81

Prob-weighted Feb 2020

IFRS 9 Stage	#	%	Exposure	ECL=0.03
1	**92,086**	**99.00**	**8,274,895,046**	**0.01**
2	**721**	**0.83**	**69,784,556**	**1.00**
3	**146**	**0.17**	**13,986,747**	**12.21**

Prob-weighted Apr 2020

IFRS 9 Stage	#	%	Exposure	ECL=0.05
1	**92,020**	**98.84**	**8,261,408,180**	**0.01**
2	**787**	**1.00**	**83,271,421**	**1.76**
3	**146**	**0.17**	**13,986,747**	**12.81**

4

Key Takeaways

Proactive Overhaul of Model Risk Management

Understand → **Identify** → **Enhance** → **Act**

- **Understand**: Changes in Market Conditions
- **Identify**: Affected Models in Scope
- **Enhance**: Validation and Benchmarking
- **Act**: Portfolio Management

Thank You

Questions? Contact us at help@economy.com

RiskTech 100 2020
Moody's Analytics
Model Validation

Chartis
RiskTech Quadrant
Category Leader
Model Validation Solutions, 2019

MOODY'S ANALYTICS

Better
Faster
Decisions

Contact Us: Content Solutions - Economics & Business Analytics Offices

West Chester, EBA-HQ
+1.610.235.5299
121 North Walnut Street, Suite 500
West Chester PA 19380
USA

New York, Corporate-HQ
+1.212.553.1653
7 World Trade Center, 14th Floor
250 Greenwich Street
New York, NY 10007
USA

London
+44.20.7772.5454
One Canada Square
Canary Wharf
London E14 5FA
United Kingdom

Toronto
+1.416.681.2133
200 Wellington Street West, 15th Floor
Toronto ON M5V 3C7
Canada

Prague
+420.23.474.7500
Pernerova 691/42
186 00 Prague 8 - Karlin,
Czech Republic

Sydney
+61.2.9270.8111
Level 10
1 O'Connell Street
Sydney, NSW, 2000
Australia

Singapore
+65.6511.4400
6 Shenton Way
#14-08 OUE Downtown 2
Singapore 068809

Shanghai
+86.21.6101.0172
Unit 2306, Citigroup Tower
33 Huayuanshiqiao Road
Pudong New Area, 200120
China

moodysanalytics.com