MOODY'S ANALYTICS

ECB's Targeted Review of Internal Models (TRIM)

Ad-interim Findings, LDP Challenges & New Regulatory Standards

October 2018

Agenda

1. Insights from the General Topics and Retail Model Inspections
2. ECB's Risk-Type-Specific Consultation on Internal Models
3. Post TRIM Towards Basel IV

1

Insights from the General Topics and Retail Model Inspections

TRIM's Timeline

All ECB's supervised banks (SIs) that have approved Pillar 1 internal models, 68 banks within the scope of the project

SSM-wide multi-year project (2016-2019)

2016/2017

Retail SMEs

Retail and Small Medium Sized Portfolios

2018

Q2

LDPs

Low-default Portfolios

Application to low default portfolios to take into account specific portfolio characteristics

2019

Outcome

Possibilities

"Risks will be modelled adequately and models will give consistent results"

Or…

Internal Rating Models might cease to exist"

2020

Outcome of General Topics Review

Carried out between 3Q-2016 and 1Q-2017. Review of Principles overarching different types of risk aligned to CRD IV, CRR and EBA's RTS.

1

Outright Non-Compliance.
Affected institutions must remediate the shortcomings within certain deadlines

2

Additional potential misalignments with further aspects of the regulatory framework.
Communicated via follow-up letters, SIs asked to respond to the JSTs within certain timescale

3

Main findings revolve around:

- Model Use, Model Change Management
- Internal Model Governance
- Implementation of IRB Approach
- Internal Validation and Audit
- Third Party Involvement

Outright Non-Compliance Cases

Model Risk Management: Lack of Model Change Policy and Back-testing Evidence*

Table 1 – General topics review: examples of non-compliance cases (non-exhaustive)

#	Description of shortcomings	Share of institutions with obligations[7]
1	Absence of a model change policy at the institution or absence of notification of material model changes to the competent authority	29%
2	Lack of evidence of annual back-testing for some rating systems	24%
3	Use of the standardised approach without formal authorisation of a permanent partial use (PPU)	19%
4	No strict separation of staff performing validation activities and staff involved in tasks of the credit risk control function (e.g. model development and monitoring)	19%
5	Current resources allocated to the internal validation function preventing a robust validation process	14%

- **Measurement of model risk across internal models at group level**
- **Implementation of an effective model risk management framework for all models**:
  1. Holistic model inventory
  2. Consistent group-wide model guidelines
  3. Clearly defined roles and responsibilities
  4. Clearly defined policies, measurement procedures and reporting

***ECB's status update on TRIM, 11 June 2018**

Follow-up Letters on Potential Misalignments

Model Risk Management: Change policy and re-rating approach, application of IRB approach, monitoring of PPU*

#	Description of issues	Share of institutions affected[8]
1	**Implementation of a model risk management framework**	
	• Despite some measurement of model risk and partial controls in place, practices not formalised/documented	31%
	• Absence of model risk management (steering and mitigation)	27%
	• Model risk not identified as a material risk by the institution (lack of awareness)	13%
2	**Application of the IRB approach and monitoring of permanent partial use (PPU) provisions**	
	• Absence of monitoring of the PPU conditions	58%
	• Absence of clear criteria for the decision of the application of the IRB approach (selection done on a case-by-case basis)	31%
3	**Decision-making responsibilities and internal reporting**	
	• Level of detail in the reporting is not appropriate	36%
	• Management body (or a designated committee thereof) does not approve all risk management policies	25%
4	**Organisation of the internal validation function**	
	• Deficiencies in the validation policy and procedures	7%
5	**Scope and frequency of the audit review of the rating systems**	
	• Lack of resources to allow a relevant assessment of the IRB requirements	36%
	• Some of the rating systems not reviewed by internal audit	31%
	• Certain aspects of the rating systems not reviewed regularly	22%

» **Monitoring of Compliance with Permanent Partial Use Provisions**:

1. Triggers for re-assessment of PPU suitability of authorized exposures (e.g. # Obligors, EAD, Av. RW Exposures)
2. Reporting Process on materiality of changes
3. Process and Guidelines for IRB exposures to become eligible for PPU

#	Description of issues	Share of institutions affected
6	**Non-rated exposures and outdated ratings**	
	• Non-rated exposures or exposures with outdated ratings not monitored by the institution	25%
	• No specific prudential treatment for non-rated exposures, or exposures with outdated ratings, or such exposures treated under the standardised approach	20%
7	**Change policy and re-rating process**	
	• Process for the re-rating and implementation of the new model not formalised	62%
	• Model change policy missing key elements such as responsibilities, impact assessment procedures or process for the classification of the changes	15%

» **Change Policy and Re-rating Process:**

1. Approved Extension or Changed Model must be part of the Change Policy
2. Immediate re-rating for material changes, otherwise impact analysis for LDPs:
   - Simulated sample of RW exposure impact based on materiality with 25% quarterly removal

***ECB's status update on TRIM, 11 June 2018**

Outcome of Retail / SMEs Review

Completed by June 2018. Ad-interim view which may change after completion of LDP assessment

1

Supervisory decision directly after investigation
for cases of non-compliance

2

A separate letter, when appropriate, accounting for:

- Horizontal Analysis
- New Regulations
- Updated ECB Guides

3

Ad-interim main findings revolve around*:

- PD Parameters:
  - Long-run Average PD
  - Risk Differentiation
- LGD Parameters:
  - Calculation of Realized LGD
  - Long-run Average LGD
- MOC and Review of Estimates

* Excl. data quality, focused mainly on Residential Real Estate

Ad-Interim PD/LGD Findings

PD and LGD Parameter Shortcomings relate to: Long-Run Averages, Risk Differentiation, Realised LGDs, Framework for Review of Estimates and MoC

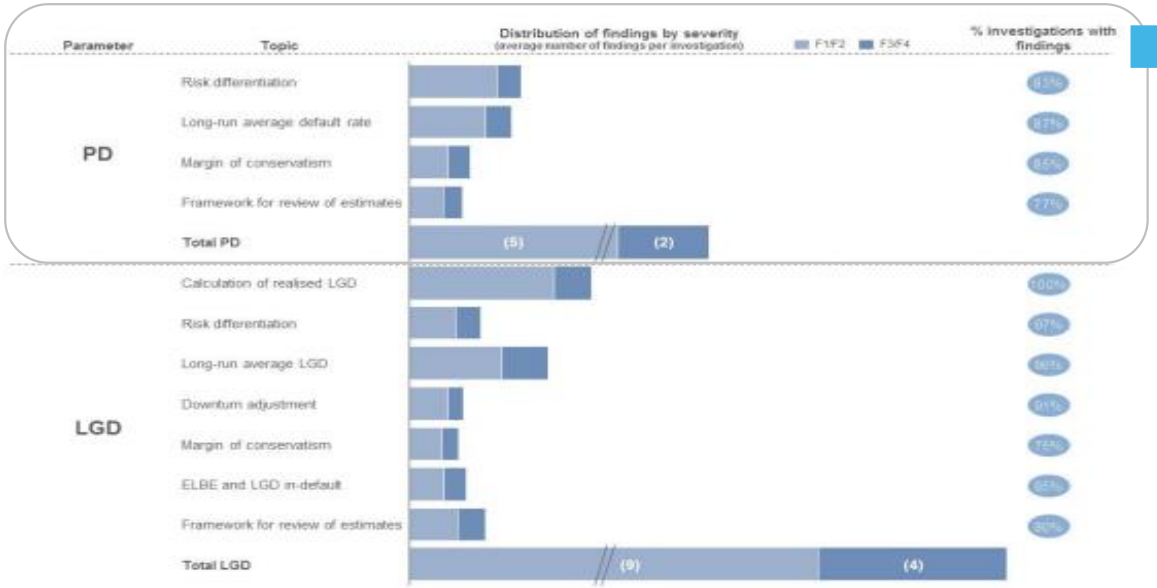


Figure 1: Overview of findings on PD/LGD in TRIM investigations

Learning from general weaknesses

1. Consideration of Relevant Risk Drivers, in particular when related to *risk of misspecification (overfitting) is present* looking at:
   1. Portfolio distribution
   2. Homogeneity
   3. Potential (ex ante) risk drivers
2. MoC framework for
   1. Structured identification of biases
   2. Sound quantification (not only judgmental)
   3. Better use of adjustments

Comparability of Parameters and RWA sensitivities across countries/industry to explain differences in risk estimates

1a

Our Experience Working with SSM Banks: Findings & Remediation Strategies

Model Change Policy

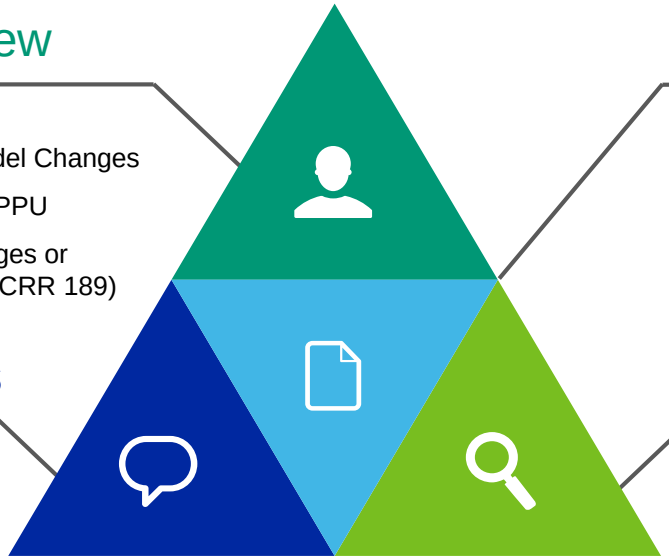
Clear Model Change Definition, Implementation and Reporting Structure

Management Holistic View

- Comprehensive Model Overview
- Governance of Roll-out Plans and Model Changes
- Adequacy of Reporting Processes on PPU
- Awareness/Approval of Material Changes or Exceptions from Established Policies (CRR 189)

Roles & Responsibilities

- Three lines of Defense
- Clearly Defined Roles and Task Allocation
- Written mandate for CRCU, interaction with Validation and remediation activities
- Management of Model Changes



Model Registry

- Holistic and Robust Model Inventory & Classification*: Model Owner, Range of Application, Materiality, Approval Date, Conditions, Weaknesses and Change Version*
- Documentation inventory, including annual review
- Adequate Archiving and Maintenance

Transparency

- Guidelines and Documentation policies, including Model Implementation Testing
- Independency and Transparency of Model Validation
- Facilitate Model Checks from Auditing
- Ex-ante and ex-post material changes/extensions and application

MA Suggested Approach

1. Focus on Model Risk with practical steps around Model Archiving and Registry
2. Introduction of a Model Risk Governance Framework across the Model Life-cycle
3. Definition of key Roles and Responsibilities for Model Risk and Workflow

Minimize Model Risk

Key requirements

Data

- ✓ Banks must use internal data to reflect their credit history
- ✓ External data to improve performance testing must reflect portfolio composition and experience (i.e. performance vs representativeness)

Estimation

- ✓ Scoring functions must lead to consistent performance over time and appropriate risk differentiation
- ✓ Perceived lack of risk differentiation is not acceptable
- ✓ Estimation criteria / data treatments must be assessed

Calibration

- ✓ Rating classes from internal data analysis
- ✓ Expert based decisions must be assessed
- ✓ PDs derived through CDT over the portfolio

MoC

- ✓ A MoC framework must be established to manage data and model assumptions
- ✓ Institutions must have a robust process for identifying all deficiencies, including data errors or any uncertainties which may lead to estimation errors

MA Suggested Approach

1. Model Performance review aligned to TRIM's validation requirements.
2. Establishment of a MoC framework and recalibration of models over internal and external data.
3. Recommendations with respect to regulatory requirements and identification of a model refinements action plan

1b

Lessons Learnt for LDP Inspections

TRIM to Expand on Data Quality Framework

Data Quality Framework throughout the IRB process, from data entry to reporting

Completeness | Accuracy | Consistency | Timeliness | Uniqueness | Validity | Traceability

MA Suggested Approach

- Focus on DQF Principles, historical data at data entry point and across data sources including all transformation and aggregation processes up to the modelling dataset
- Perform mandatory tests across key risk drivers/variables with highest weights e.g. default flag, cash flow data, obligor size, financial ratios, external rating

Margin of Conservatism

Model Deficiencies Leading to Biasness addressed through 5 key blocks

1. **Methods**
2. **Processes**
3. **Controls**
4. **Data**
5. **IT systems**

Deficiencies

- Data representativeness
- Data insufficiency
- Default definition changes
- Data quality
- Future events
- Methodological shortcomings
- Changes to underwriting standards, risk appetite, etc.
- Changes in market or legal environment
- Estimator errors

1. **Identification of Deficiencies**
2. **Establishment of adjustments and MoC**
3. **Monitoring**
4. **Documentation**
5. **Roadmap to address deficiencies**

MA Suggested Approach

1. Identify deficiencies leading to potential biasness or uncertainty in the risk quantification
2. Establish effective governance processes to address these deficiencies
3. Review of data quality, policies, model adequacy
4. Review of model design, methodology and portfolio representativeness e.g. risk drivers, discriminatory powers, sensitivity analysis, rating distribution, qualitative variables
5. Use of bank LRA default rates / external data for model performance e.g. predictive power, calibration, PS, rank ordering (KS)
6. Ensure alignment with risk appetite / credit policies

Three Phased Approach

In preparation, during and post on-site inspections

PHASE 1
Model Framework & Performance Review

PHASE 2
Supervisory Review Preparation & Support

PHASE 3
Supervisory Feedback

Model Framework

Benchmarking

Margin of Conservatism

Back-testing

Supervisory Review Preparation

Supervisory Feedback

2

ECB’s Risk-Type-Specific Consultation on Internal Models

ECB’s Risk-Type-Specific Consultation Paper

Ensuring consistency over PD models implementation

1 **Error-free implementation framework**

2 **Ent-to-end data quality framework**

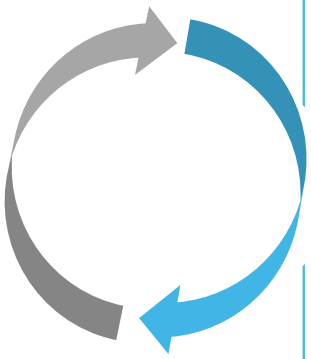
3 **Modelling PDs in a LDP context, when systematic risk is material**

Error-free Implementation Framework

Rationalizing systems, implementation and governance processes

Ex ante framework

- Data flows workflows across ETLs and storage, specifications (functional/technical),
- Organizational wide policy and procedures, documentation
- Audit trail and on-going validation framework



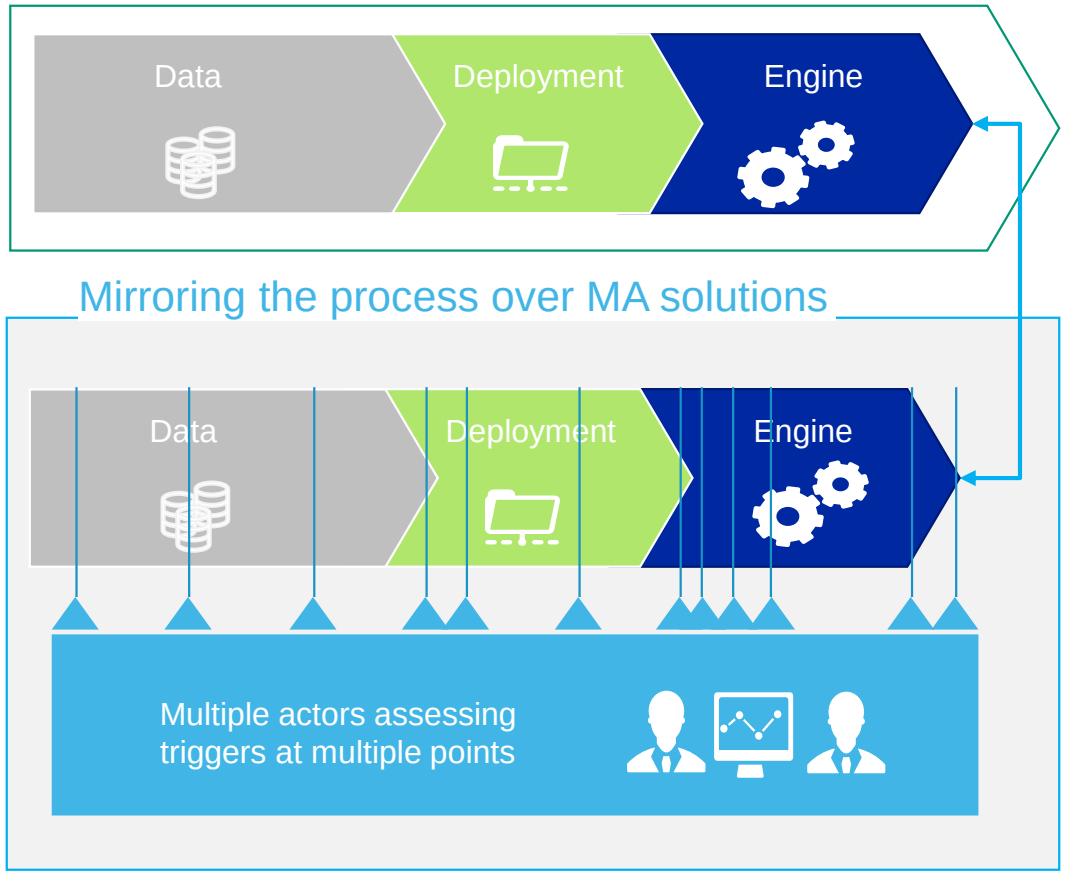
Ex post controls

- **Comprehensive implementation testing triggers across model lifecycle, IT and regulatory changes**
- **Granular testing across units/components/modules and multiple relevant stakeholders (code testers, developers,..)**
- **Documented tests even under stress scenarios**

Strong expectation on the historical consistency of the implementation framework

How do MA's Solutions Facilitate Compliance

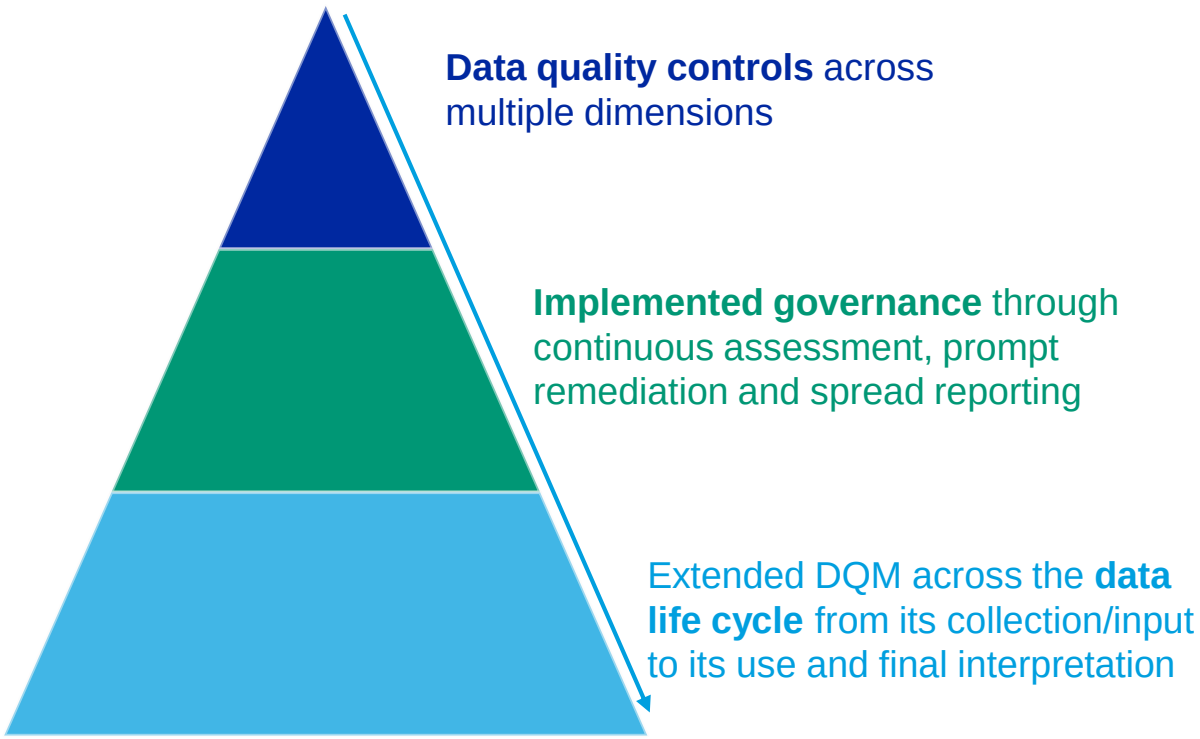
Leveraging an integrated platform



- **Unique environment** where data flows are assessed by multiple type of stakeholders
- **Ongoing triggers** and possibility to **simulate** stress scenarios (e.g. massive release of new models, inaccurate mapping of the models, wrong data migration,..)
- **Structured analytical assessments** at multiple points in the process

End-to-end Data Quality Framework

Ensuring quality of the data across the whole data life cycle

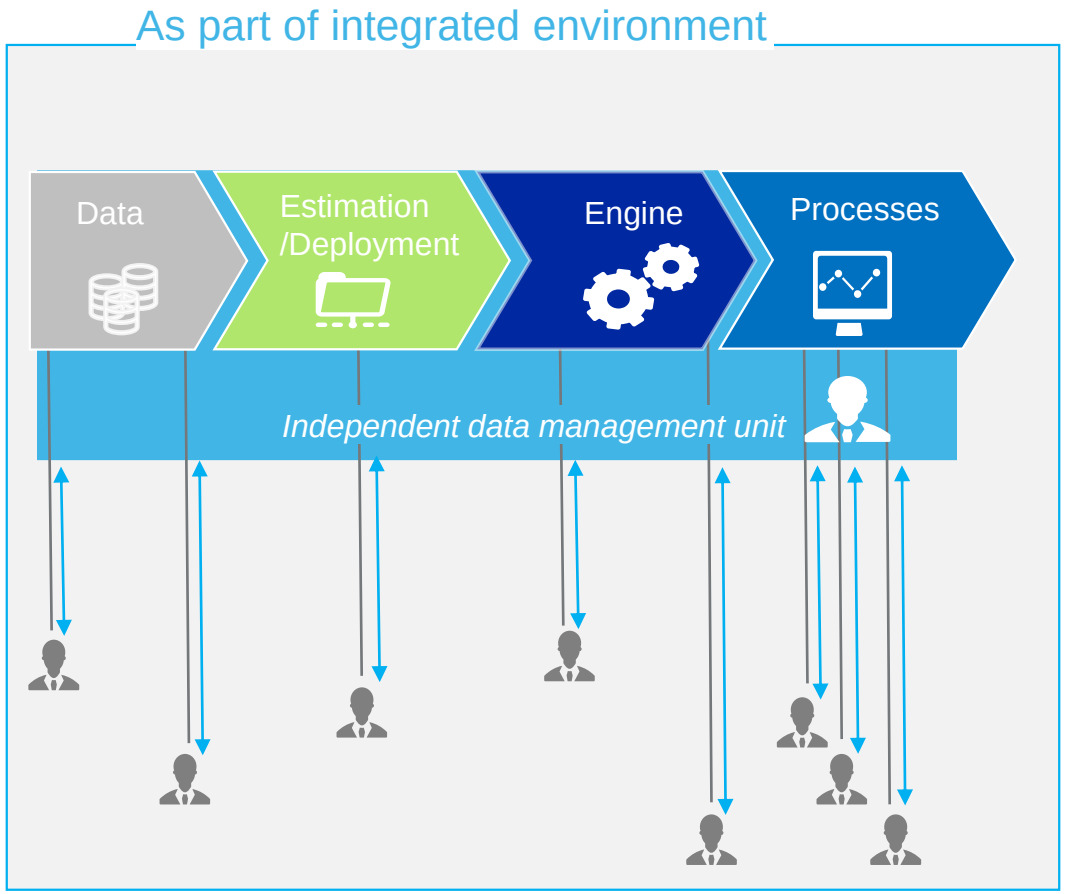


Key data qualities

- **Correct**
- **Complete**
- **Appropriate**

How do MA's Solutions Facilitate Compliance

Leveraging an integrated platform



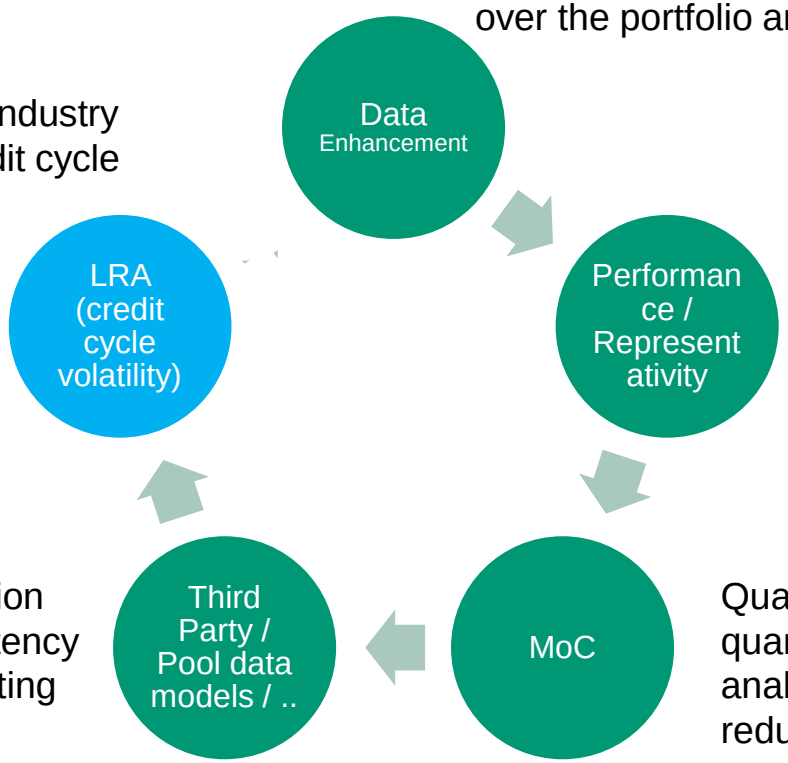
- Structured and formalized DQ framework **across the data life cycle**
- Automated exchange of information and **relevant reporting with key data and model users or <u>relevant stakeholders</u>**
- Information flow enabling expert/qualitative evaluation of data **appropriateness** from key business owners

Modelling PDs for LDPs 1/2

Overcoming lack of data issues

Representative and consistent data over the portfolio and across time

Geography-industry relevant credit cycle information



"*ECB's view is that Banks may still use external data if the information gained from the use of external data outweighs any drawbacks*"

Internalization and consistency of the resulting measures

Qualitative & quantitative analysis to reduce bias

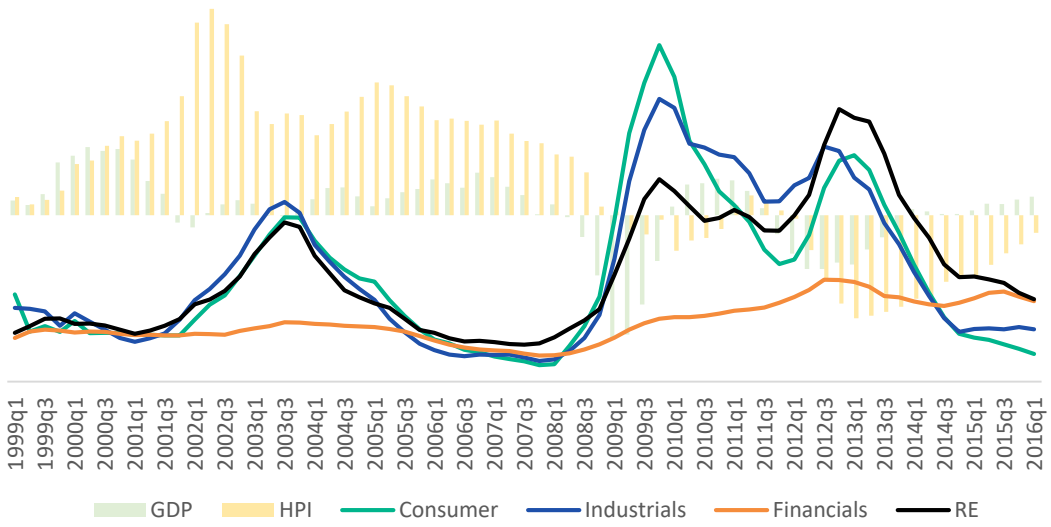
RWE Amounts sensitivity and peer comparison across the process is key to avoid systematic or material bias

Modelling PDs for LDPs 2/2

Leveraging MA data and EDF modelling framework

- having enough defaults to calibrate rating models does not automatically mean that there is enough data for LRA purposes; variability in the economic environment is needed
- internal data might be adequate for overall portfolio calibration but higher granularity might be needed leveraging industry-level data per country/region and additional drivers for LRA purpose

Indicative Credit Cycles of a European sovereign



Through CRD / DRD and EDF models

- Historical series of DR / EDF
- Global / Country specific tendencies / adjustments
- Global / Industry specific tendencies / adjustments

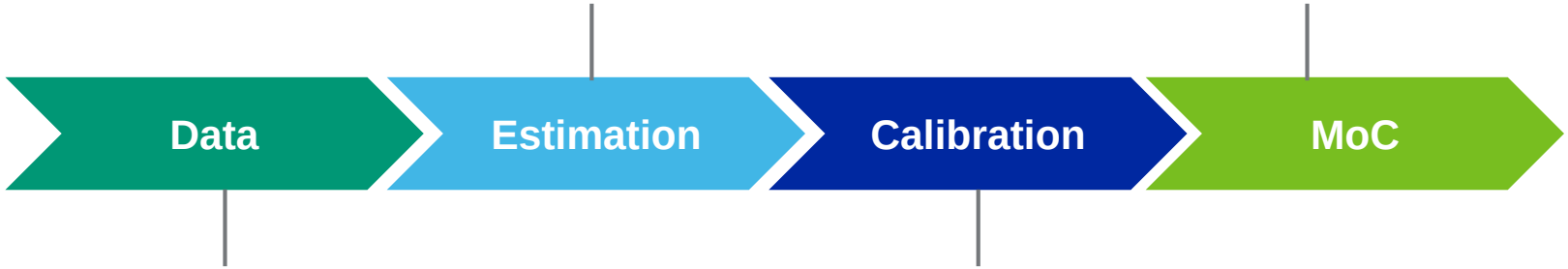
When Systematic Risk is Material 1/2

Highlighting forward looking and macroeconomic scenarios components

"The rating/grade/pool assignment process should also adequately anticipate and reflect risk over longer time horizons and take into account plausible changes in economic conditions"

- ✓ Balance between drivers predictive over short and long (2/3 years) time horizon

- ✓ Adjustments based on
  - ✓ Credit migrations not strictly due to idiosincratic risks
  - ✓ Gap between external and internal



- ✓ Relevant historical default patterns

- ✓ Predictive of risk over longer time horizon
- ✓ Performance under different macroeconomic scenarios

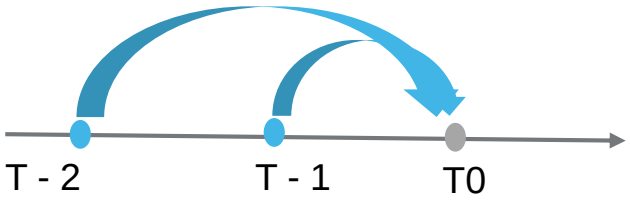
When Systematic Risk is Material 2/2

Enriching the model design and validation framework

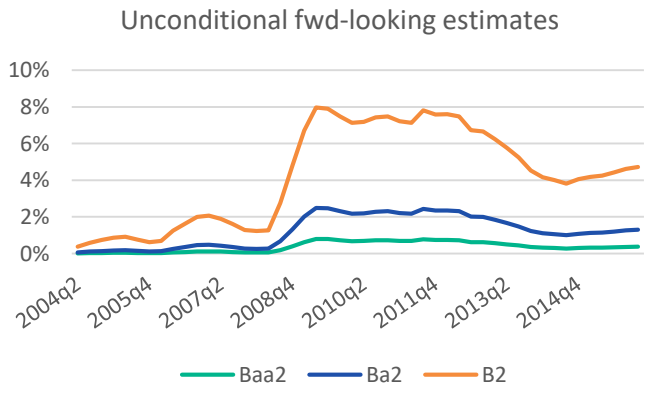
Modelling

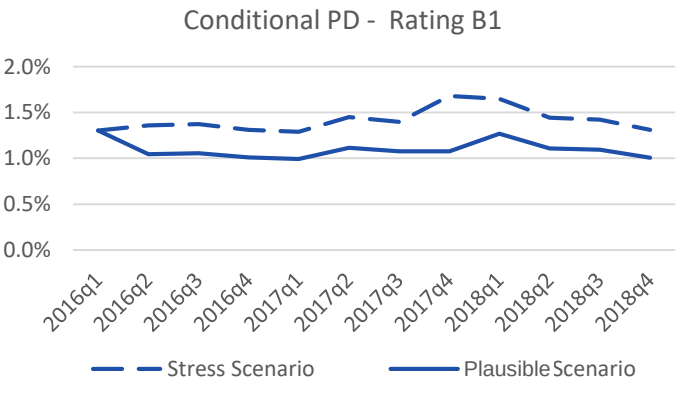
- Historical data assessment
- Macroeconomic drivers sensitivities
- CT recalibration including expected 2/3 years forecasted rates

Validation



Through MA forward looking model framework





3

Post TRIM Towards Basel IV

SREP and Annual Validation

TRIM Ramifications

TRIM Final guide

from 2020

TRIM into SREP

Annual Model Validation

Merging Impact of TRIM into SREP

Internal capital allocation

*(i) *Banks are expected to make use of IRB parameters, including adjusted ones, to calculate their internal capital under the ICAAP (RWA could also be used as an additional driver).*

Ongoing Monitoring and Deep-dive

Group level and sub-consolidated

Banks will **be required to conduct ongoing monitoring and annual validation of their models**. In certain cases including a deep-dive.

Top-down view (Art.33 RTS) Senior Management will have to be informed of the outcome of the validation on an aggregate basis for each rating system at least annually

Risk profiles and the comparison of realized and expected default rates should be reported to senior management more frequently than annually

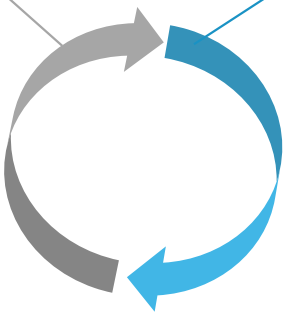
*ECB's TRIM Feb. 2017

Strategically Manage IRB models

Modelling

Strategy definition

1. High risk and highly systematic risky assets may become relevant as part of portfolio review strategies under IFRS9/RWA perspective
2. Non-risk related volatility may affect capital requirements through prudential buffers leading banks in need of additional capital
3. Credit processes / limits / pricing strategies must be revised to account for revised risk parameters / MoC



Modelling

1. Models may no longer be compliant following a strategic portfolio review
2. PD may not be calibrated on a consistent historical series (by process and portfolio characteristics) leading to under/over estimated values or TTC/PiT bias
3. Additional data requirements, increase in variables, new credit models and parameters under IFRS 9

Internal models refinement needs to be part of the strategic process

MOODY'S
ANALYTICS

Marta Cerina
Director, Moody's Analytics
Marta.cerina@moodys.com
+44 (207) 772 5503

Leonardo Checchi
Associate Director, Moody's Analytics
Leonardo.checchi@moodys.com
+44 (780) 053 1816

moodysanalytics.com

Confidential and proprietary – Not to be distributed without the prior written consent of Moody's Analytics

© 2017 Moody's Corporation, Moody's Investors Service, Inc., Moody's Analytics, Inc. and/or their licensors and affiliates (collectively, "MOODY'S"). All rights reserved.

CREDIT RATINGS ISSUED BY MOODY'S INVESTORS SERVICE, INC. AND ITS RATINGS AFFILIATES ("MIS") ARE MOODY'S CURRENT OPINIONS OF THE RELATIVE FUTURE CREDIT RISK OF ENTITIES, CREDIT COMMITMENTS, OR DEBT OR DEBT-LIKE SECURITIES, AND MOODY'S PUBLICATIONS MAY INCLUDE MOODY'S CURRENT OPINIONS OF THE RELATIVE FUTURE CREDIT RISK OF ENTITIES, CREDIT COMMITMENTS, OR DEBT OR DEBT-LIKE SECURITIES. MOODY'S DEFINES CREDIT RISK AS THE RISK THAT AN ENTITY MAY NOT MEET ITS CONTRACTUAL, FINANCIAL OBLIGATIONS AS THEY COME DUE AND ANY ESTIMATED FINANCIAL LOSS IN THE EVENT OF DEFAULT. CREDIT RATINGS DO NOT ADDRESS ANY OTHER RISK, INCLUDING BUT NOT LIMITED TO: LIQUIDITY RISK, MARKET VALUE RISK, OR PRICE VOLATILITY. CREDIT RATINGS AND MOODY'S OPINIONS INCLUDED IN MOODY'S PUBLICATIONS ARE NOT STATEMENTS OF CURRENT OR HISTORICAL FACT. MOODY'S PUBLICATIONS MAY ALSO INCLUDE QUANTITATIVE MODEL-BASED ESTIMATES OF CREDIT RISK AND RELATED OPINIONS OR COMMENTARY PUBLISHED BY MOODY'S ANALYTICS, INC. CREDIT RATINGS AND MOODY'S PUBLICATIONS DO NOT CONSTITUTE OR PROVIDE INVESTMENT OR FINANCIAL ADVICE, AND CREDIT RATINGS AND MOODY'S PUBLICATIONS ARE NOT AND DO NOT PROVIDE RECOMMENDATIONS TO PURCHASE, SELL, OR HOLD PARTICULAR SECURITIES. NEITHER CREDIT RATINGS NOR MOODY'S PUBLICATIONS COMMENT ON THE SUITABILITY OF AN INVESTMENT FOR ANY PARTICULAR INVESTOR. MOODY'S ISSUES ITS CREDIT RATINGS AND PUBLISHES MOODY'S PUBLICATIONS WITH THE EXPECTATION AND UNDERSTANDING THAT EACH INVESTOR WILL, WITH DUE CARE, MAKE ITS OWN STUDY AND EVALUATION OF EACH SECURITY THAT IS UNDER CONSIDERATION FOR PURCHASE, HOLDING, OR SALE.

MOODY'S CREDIT RATINGS AND MOODY'S PUBLICATIONS ARE NOT INTENDED FOR USE BY RETAIL INVESTORS AND IT WOULD BE RECKLESS AND INAPPROPRIATE FOR RETAIL INVESTORS TO USE MOODY'S CREDIT RATINGS OR MOODY'S PUBLICATIONS WHEN MAKING AN INVESTMENT DECISION. IF IN DOUBT YOU SHOULD CONTACT YOUR FINANCIAL OR OTHER PROFESSIONAL ADVISER.

ALL INFORMATION CONTAINED HEREIN IS PROTECTED BY LAW, INCLUDING BUT NOT LIMITED TO, COPYRIGHT LAW, AND NONE OF SUCH INFORMATION MAY BE COPIED OR OTHERWISE REPRODUCED, REPACKAGED, FURTHER TRANSMITTED, TRANSFERRED, DISSEMINATED, REDISTRIBUTED OR RESOLD, OR STORED FOR SUBSEQUENT USE FOR ANY SUCH PURPOSE, IN WHOLE OR IN PART, IN ANY FORM OR MANNER OR BY ANY MEANS WHATSOEVER, BY ANY PERSON WITHOUT MOODY'S PRIOR WRITTEN CONSENT.

All information contained herein is obtained by MOODY'S from sources believed by it to be accurate and reliable. Because of the possibility of human or mechanical error as well as other factors, however, all information contained herein is provided "AS IS" without warranty of any kind. MOODY'S adopts all necessary measures so that the information it uses in assigning a credit rating is of sufficient quality and from sources MOODY'S considers to be reliable including, when appropriate, independent third-party sources. However, MOODY'S is not an auditor and cannot in every instance independently verify or validate information received in the rating process or in preparing the Moody's publications.

To the extent permitted by law, MOODY'S and its directors, officers, employees, agents, representatives, licensors and suppliers disclaim liability to any person or entity for any indirect, special, consequential, or incidental losses or damages whatsoever arising from or in connection with the information contained herein or the use of or inability to use any such information, even if MOODY'S or any of its directors, officers, employees, agents, representatives, licensors or suppliers is advised in advance of the possibility of such losses or damages, including but not limited to: (a) any loss of present or prospective profits or (b) any loss or damage arising where the relevant financial instrument is not the subject of a particular credit rating assigned by MOODY'S.

To the extent permitted by law, MOODY'S and its directors, officers, employees, agents, representatives, licensors and suppliers disclaim liability for any direct or compensatory losses or damages caused to any person or entity, including but not limited to by any negligence (but excluding fraud, willful misconduct or any other type of liability that, for the avoidance of doubt, by law cannot be excluded) on the part of, or any contingency within or beyond the control of, MOODY'S or any of its directors, officers, employees, agents, representatives, licensors or suppliers, arising from or in connection with the information contained herein or the use of or inability to use any such information.

NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE ACCURACY, TIMELINESS, COMPLETENESS, MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE OF ANY SUCH RATING OR OTHER OPINION OR INFORMATION IS GIVEN OR MADE BY MOODY'S IN ANY FORM OR MANNER WHATSOEVER.

Moody's Investors Service, Inc., a wholly-owned credit rating agency subsidiary of Moody's Corporation ("MCO"), hereby discloses that most issuers of debt securities (including corporate and municipal bonds, debentures, notes and commercial paper) and preferred stock rated by Moody's Investors Service, Inc. have, prior to assignment of any rating, agreed to pay to Moody's Investors Service, Inc. for appraisal and rating services rendered by it fees ranging from $1,500 to approximately $2,500,000. MCO and MIS also maintain policies and procedures to address the independence of MIS's ratings and rating processes. Information regarding certain affiliations that may exist between directors of MCO and rated entities, and between entities who hold ratings from MIS and have also publicly reported to the SEC an ownership interest in MCO of more than 5%, is posted annually at www.moodys.com under the heading "Investor Relations — Corporate Governance — Director and Shareholder Affiliation Policy."

Additional terms for Australia only: Any publication into Australia of this document is pursuant to the Australian Financial Services License of MOODY'S affiliate, Moody's Investors Service Pty Limited ABN 61 003 399 657AFSL 336969 and/or Moody's Analytics Australia Pty Ltd ABN 94 105 136 972 AFSL 383569 (as applicable). This document is intended to be provided only to "wholesale clients" within the meaning of section 761G of the Corporations Act 2001. By continuing to access this document from within Australia, you represent to MOODY'S that you are, or are accessing the document as a representative of, a "wholesale client" and that neither you nor the entity you represent will directly or indirectly disseminate this document or its contents to "retail clients" within the meaning of section 761G of the Corporations Act 2001. MOODY'S credit rating is an opinion as to the creditworthiness of a debt obligation of the issuer, not on the equity securities of the issuer or any form of security that is available to retail investors. It would be reckless and inappropriate for retail investors to use MOODY'S credit ratings or publications when making an investment decision. If in doubt you should contact your financial or other professional adviser.

Additional terms for Japan only: Moody's Japan K.K. ("MJKK") is a wholly-owned credit rating agency subsidiary of Moody's Group Japan G.K., which is wholly-owned by Moody's Overseas Holdings Inc., a wholly-owned subsidiary of MCO. Moody's SF Japan K.K. ("MSFJ") is a wholly-owned credit rating agency subsidiary of MJKK. MSFJ is not a Nationally Recognized Statistical Rating Organization ("NRSRO"). Therefore, credit ratings assigned by MSFJ are Non-NRSRO Credit Ratings. Non-NRSRO Credit Ratings are assigned by an entity that is not a NRSRO and, consequently, the rated obligation will not qualify for certain types of treatment under U.S. laws. MJKK and MSFJ are credit rating agencies registered with the Japan Financial Services Agency and their registration numbers are FSA Commissioner (Ratings) No. 2 and 3 respectively.

MJKK or MSFJ (as applicable) hereby disclose that most issuers of debt securities (including corporate and municipal bonds, debentures, notes and commercial paper) and preferred stock rated by MJKK or MSFJ (as applicable) have, prior to assignment of any rating, agreed to pay to MJKK or MSFJ (as applicable) for appraisal and rating services rendered by it fees ranging from JPY200,000 to approximately JPY350,000,000.

MJKK and MSFJ also maintain policies and procedures to address Japanese regulatory requirements.