Model Risk Management
Driving the value in modelling

Risk Advisory – France
December 2016
## Agenda

<table>
<thead>
<tr>
<th>Section</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ouverture</strong></td>
<td>Hervé Phaure, Deloitte</td>
</tr>
<tr>
<td><strong>Introduction</strong></td>
<td>Nadège Grennepois, Deloitte</td>
</tr>
<tr>
<td><strong>Intervention</strong></td>
<td>Christopher Lotz, BaFin</td>
</tr>
<tr>
<td><strong>Table-Ronde et Q&amp;A</strong></td>
<td>Nathalie Bouez, BNP Paribas, Guillaume Figer, Société Générale, Tabourin, BPCE, Christopher Lotz, BaFin</td>
</tr>
<tr>
<td><strong>Conclusions</strong></td>
<td>Hervé Phaure, Deloitte</td>
</tr>
<tr>
<td><strong>Networking Cocktail</strong></td>
<td></td>
</tr>
</tbody>
</table>
Introduction

Nadège Grennepois
CRD IV / CRR

Defines Model Risk (Art. 3.1.11) and the process by which the Competent Authorities should assess how the institutions manage and implement policies and processes to evaluate the exposure to Model Risk as part of the Operational Risk (Art. 85).

Guidelines on SREP

The ‘Guidelines on common procedures and methodologies for the supervisory review and evaluation process’ define the main activities that the Competent Authorities should assess in the institution’s exposure to model risk arising from the use of internal models in its main business areas and operations. In particular, the Competent Authorities should consider to what extent, and for which purposes, the institution uses models to make decisions and its level of awareness (Management Body and Senior Management) of and how it manages model risk.

According to SREP Guidelines, the model risk can be split into two distinct forms of risk with two different impacts risk profiles.

<table>
<thead>
<tr>
<th>Form of risks</th>
<th>Risk profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Risk relating to the underestimation of own funds requirements by regulatory approved models (e.g. internal ratings-based (IRB) models for credit risk)&quot;</td>
<td>“Competent authorities should consider the model risk as part of the assessment of specific risks to capital (e.g. IRB model deficiency is considered as part of the credit risk assessment) and for the capital adequacy assessment“</td>
</tr>
<tr>
<td>&quot;Risk of losses relating to the development, implementation or improper use of any other models by the institution for decision-making (e.g. product pricing, evaluation of financial instruments, monitoring of risk limits, etc.)&quot;</td>
<td>“Competent authorities should consider the risk as part of the assessment of operational risk” and it should be evaluated within this perimeter</td>
</tr>
</tbody>
</table>
Impact of the New Regulations and Standards

**IMPACT IRB**
- EBA Guidelines on PD, LGD estimation and treatment of defaulted assets.
- **Default Definition revision** (EBA, 28/09/2016)

**IMPACT FRTB**
The Fundamental Review of the Trading Book includes updates to both the **advanced and standardized models** as well as **stricter disclosure requirements and validation standards**. A key overall aim is to reduce the differences between RWAs for different banks with similar portfolios. It will involve major changes both for banks with model permissions and for those without.

**Impact TRIM**
Impact TRIM exercise is integrated in the international efforts and takes into consideration all the possible upcoming changes in the supervisory framework regarding the **internal models**. A **targeted approach is envisaged to topics and models**, selected on the basis of supervisory knowledge of material issues requiring harmonization and supervisors’ experience with particular portfolios and models.

**IMPACT OF IFRS9**
The introduction of the IFRS 9 Impairments standard is demanding that **banks use a new set of credit risk models**; these models must be developed, deployed and maintained, which will literally double the number of Risk parameters models to manage.

---

The **EBA is mandated to develop Binding Technical Standards (BTS), Guidelines and Reports to assess internal models** with the aim of ensuring a harmonized implementation of the rules for Internal Rating Based (IRB) Approaches for credit risk, Internal Model Methods (IMM) for counterparty credit risk, Advanced Measurement Approaches (AMA) for operational risk and Internal Models Approaches (IMA) for market risk.
Types of Models in the Scope

Comprehensive Model Coverage

A large global bank has a wide range of model types that are subject to governance and model risk management (examples below). Model risk is connected both to the underestimation of own funds requirements by regulatory approved models and to the improper application of any other models used for “managerial” purposes.

<table>
<thead>
<tr>
<th>MARKET AND LIQUIDITY RISK MODELS</th>
<th>CREDIT &amp; COUNTERPARTY RISK MODELS</th>
<th>OPERATIONAL RISK MODELS</th>
<th>COMPLIANCE MODELS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• VaR (inc. Stressed VaR, IRC)</td>
<td>• PD, LGD and EAD</td>
<td>• Loss Distribution Approach Model</td>
<td>• Anti-Money Laundering (AML)</td>
</tr>
<tr>
<td>• ALM &amp; Liquidity Risk</td>
<td>• Risk rating models</td>
<td>• Integration Model</td>
<td>• Anti Fraud</td>
</tr>
<tr>
<td>• Expected Shortfall</td>
<td>• Exposure and CVA</td>
<td></td>
<td>• Trader surveillance</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PORTFOLIO &amp; FINANCIAL RISK MODELS</th>
<th>DECISION SUPPORT MODELS</th>
<th>VALUATION &amp; PRICING MODELS</th>
<th>FINANCE MODELS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Capital forecasting</td>
<td>• LOB models for customer targeting-marketing</td>
<td>• Derivatives</td>
<td>• P&amp;L Attribution</td>
</tr>
<tr>
<td>• Stress testing</td>
<td>• Credit underwriting</td>
<td>• Structured products</td>
<td>• Cash flow /NPV/Ratio Analysis</td>
</tr>
<tr>
<td>• Econometric models</td>
<td>• Risk based collection models</td>
<td>• Risk based pricing tools/models</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MARKETING MODELS</th>
<th>INSURANCE MODELS</th>
<th>INVESTMENT MANAGEMENT</th>
<th>OTHER MODELS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Marketing models</td>
<td>• Actuarial models</td>
<td>• Trading</td>
<td>• Corporate Finance Models (e.g. M&amp;A, LBO, MBO)</td>
</tr>
<tr>
<td>• Client Targeting</td>
<td>• Loss Forecasting</td>
<td>• Security / Asset Pricing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Reserving models</td>
<td>• Portfolio Allocation</td>
<td></td>
</tr>
</tbody>
</table>
Elements of an objective MRM framework

ORGANISATION AND GOVERNANCE

- Existence of a Model Risk Management that has been approved by the Board, who receive periodic reports regarding compliance.
- Existence of a Model Risk function that reports directly to the CRO and is responsible for the MRM framework and the governance.
- Existence of a model validation function responsible for the independent validation of models.

MODEL LIFECYCLE MANAGEMENT

- Includes the model development, documentation, inventory, classification and follow-up:
  - Comprehensive inventory covering all existing models and framework scope.
  - Models are classified according to the level of risk and prioritised.
  - The documentation should include description, key variables, assumptions and algorithms.

MODEL RISK QUANTIFICATION

- Quantitative techniques for model risk mitigation (beyond regulatory requirements) regarding:
  - Data, sensitivity to errors or absence of variables;
  - Estimates, sensitivity of estimates (maximum impact, alternative models);
  - Uses, predictive power evolution, impact of erroneous use, etc.

MODEL CONTROL FRAMEWORK

- Models assigned the highest level of risk are subject to continuous assessment.
- In addition to the above, all models should be re-evaluated by Validation:
  - Annually.
  - If they undergo material changes.
- Before they are deployed to production, they should have been approved.

MODEL RISK MANAGEMENT PROCESSES & TECHNOLOGY

The MRM framework should be supported by a technological platform.

© 2016 Deloitte Conseil
Banks need to develop more models in order to comply with parallel regulations, typically:
- IFRS9 Framework Implementation and Forward Looking Integration
- IRB Models
- ECB Regular Stress Tests

Banks should consider Model Risk limits within Risk Appetite Framework.

Regulators want to have a core understanding of the way banks develop, document, use, monitor, set up and maintain inventories, validate and control models for credit, finance and marketing activities.
Introduction

Christopher Lotz
From Model Validation to Model Risk Management
The regulator’s perspective
Disclaimer

All statements in this presentation reflect solely the presenter’s personal views and should not be construed to represent BaFin.
Louis Bachelier, “Theorie de la speculation” (Paris 1900)

“The factors that determine activity on the Exchange are innumerable, with events, current or expected, often bearing no apparent relation to price variation.

Beside the somewhat natural causes for variation come artificial causes: The Exchange reacts to itself, and the current trading is a function, not only of prior trading, but also of its relationship to the rest of the market. The determination of this activity depends on an infinite number of factors. It is thus impossible to hope for mathematical forecasting. Contradictory opinions about these variations are so evenly divided that at the same instant buyers expect a rise and sellers a fall.”
All models have model risk...

1. Models were introduced because real world too complex for rules / standard formula
2. Models acted as a control for risks
3. Modelling hubris: „Everything can be modelled“ - model risks not acknowledged
4. Severe crisis of trust in internal models (although most IRB models went life only after 2008)
5. More rules and restrictions for internal models?

At the same time: Models became more and more pervasive (Pillar II, Margin Models, Prudent Valuation, IFRS 9, ...)

© 2016 Deloitte Conseil
Excursion: What creates mistrust in models?

Examples:

• Losses which surpass model forecasts by many magnitudes
• Variances between internal model results for seemingly identical portfolios
• Huge benefits from diversification
• Model changes which all seem sensible individually, but can lower capital over time (“model drift”)
• But most of all: little transparency and communication, while models were sometimes used as a free ticket to justify almost everything.
Excursion: Trend towards Lemon Models
(cf. George A. Akerlof: The market for „lemons“, 1970)

Driver: Asymmetric information between principal (the supervisor) and agent (the bank)
Solution: Provide transparency about model performance!
Alternatives: Screening vs Signalling

Adverse Selection

Some models may in some circumstances have less conservative outcomes

In order to compensate, more models are pushed into the aggressive direction

Supervisors are concerned about appropriateness of models and introduce general floors / multipliers / add-ons

„Lemon“ is a colloquial american expression for a low quality car

"Lemon" is a colloquial american expression for a low quality car

"Lemon" is a colloquial american expression for a low quality car

"Lemon" is a colloquial american expression for a low quality car

"Lemon" is a colloquial american expression for a low quality car

"Lemon" is a colloquial american expression for a low quality car

"Lemon" is a colloquial american expression for a low quality car

"Lemon" is a colloquial american expression for a low quality car

"Lemon" is a colloquial american expression for a low quality car
Introduction of models for regulatory purposes
Requires a portfolio view of models

Interlinked models need to be seen as a portfolio rather than a set of unrelated elements!
Challenges in Validation

1. Separation of Model RM from other QA processes
2. Triggers for ad-hoc validation
3. Consistent approach across model categories and the group, specific to the individual needs
4. Structured & readable individual validation reports
5. Aggregation of validation results
6. List of „Risks not in Model“
7. Conclusions and Action Points
8. Implementation of action points, follow-up & escalation
Traditional validation often does not cover all sources of model risk:

- Input data, parameters and expert judgement
- Mappings, proxies, model points
- Choice of methodologies
- IT implementation
- Process quality
- Outputs
- Consistency between models
- With regard to full portfolio or individual portfolios?
- Use
While proper validation is at the core of model risk management...

**List of validation tools**
- Testing against experience, also for hypothetical portfolios
- Profit & Loss or Risk Attribution (a.k.a. Analysis of Change)
- Sensitivity Testing
- Stability Testing
- Stress Test & Scenario Analysis, also reverse
- Benchmarking & peer review
- Use of simplified models
- Partial replication / manual tracking of steps in the model process
- etc
... and evolved into comprehensive validation ...

- Model Coverage
- Model Design
- Model Inputs (Parameters, assumptions, exposure data, market data)
- Processes & Data Quality
- Model Results
- Documentation & Reporting
- Use of the model results
... model risk management is much more than model validation:

**MODEL DEVELOPMENT**
Development Standards
Strategies for future model improvements

**MODEL GOVERNANCE**
Internal and external model approval processes
Framework for limits, conditions and recommendations
Centralized responsibility for model risk

**ONGOING MODEL MONITORING**
Regular Performance Checks
Quantification of Model Uncertainty

**MODEL OVERVIEW**
Maintenance of Model Inventory
Aggregated Model Performance & Risk Reporting
Overall Model Risk Assessment
EUROPE

Focus on traditional validation

- Numerous validation requirements appear throughout the CRR and beyond... (MR, CR, OR, Margin Models, Stress Testing, ...)

- BUT: Each requirement is focused on the needs of the particular model at hand.

- Many regulators still concentrate on validation within the boundaries of one risk category, rather than as an overarching concept. Regulators seem to adopt a bottom up approach to address the challenge.

- Compare this to Solvency II: One article + L2 / L3 standards

Missing Model Risk and Model Risk Management

- Currently no overarching concept of validation in EU regulation.

- Currently no concept of „model risk“, or a desired or required precision or admissible model uncertainty in EU regulation.

- Currently no concept of „Portfolio of Models“, and hence no concept of model risk management in EU regulation

The portfolio of models is at the center of model risk management

**Why portfolio of models?**

Models do not sit one next to the other without connection, but are interlinked:

1. One model’s outputs feeds other models
2. Results from different models are aggregated, therefore there is a need for consistency
3. Some models share the same risk drivers

A holistic and integrated view of models is necessary!
Model Risk Management answers the question: How to improve controls around models?

Albert Einstein: “We can not solve our problems with the same level of thinking that created them.”

Rules are unable to deal with the complexity of models

Enter “Principle-Based Model Risk Management”

Transparency is key: Remember the market for lemons

Model Risk Management may also help in making transparent the true costs of maintaining complex models, and therefore reduce unnecessary complexity
Some Principles of Model Risk Management

1. **Comprehensive** – covers models from beginning to end, from input data to final capital (or other) figure
2. **Holistic** – covers data, methodology, processes, governance etc
3. **Adapted** – recognizes the interdependencies between model
4. **Integrated** – summarizes validation results across models
5. **Action-oriented** – results trigger model improvements
6. **Practice-based** – involves business
7. **Focused** – bears in mind the ultimate purpose of the model
8. **Documented** – all methodologies, processes and results are properly documented
9. **Relevant** – senior management gets involved
Smoother & more efficient interaction between bank and supervisor

- Reliable internal model risk management
- Standardized reporting of internal validation results

Targeted supervision:
- Efficient on-going model monitoring
- Reduced frequency & scope of on-site investigations
Table ronde

Guillaume Figer
Nathalie Bouez
Guillaume Tabourin
Christopher Lotz
Tour de table
Questions Réponses
ORGANISATION ET GOUVERNANCE
Comment est organisée la fonction Model Risk Management au sein de votre établissement ?
Reporte-t-elle au CRO ?

GESTION DU CYCLE DE VIE DES MODÈLES
Selon-vous, quels types de modèles sont dans le périmètre MRM ? disposez-vous d’inventaires de ces modèles et d’une méthode de classification de ces modèles ?

VALIDATION DES MODÈLES
Seriez-vous prêts à envisager d’externaliser vos fonctions de validation de modèles ? sinon pourquoi ?

QUANTIFICATION DU RISQUE DE MODÈLE
Comment définissez-vous la quantification du risque de modèle ?

PROCESS
Comment est envisagé le projet de définition d’un dispositif MRM dans votre établissement ?

IMPACT SUR LA PROFITABILITÉ DE LA BANQUE
Pensez-vous que l’absence d’une gestion du risque de modèle puisse avoir un impact négatif sur la profitabilité de la banque, avez-vous des retours d’expérience
About Deloitte

Deloitte refers to one or more of Deloitte Touche Tohmatsu Limited, a UK private company limited by guarantee, and its network of member firms, each of which is a legally separate and independent entity. Please see www.deloitte.com/about for a detailed description of the legal structure of Deloitte Touche Tohmatsu Limited and its member firms. In France, Deloitte SAS is the member firm of Deloitte Touche Tohmatsu Limited, and professional services are provided by its subsidiaries and affiliates.

Deloitte provides audit, tax, consulting, and financial advisory services to public and private clients spanning multiple industries. With a globally connected network of member firms in more than 150 countries, Deloitte brings world-class capabilities and high-quality service to clients, delivering the insights they need to address their most complex business challenges. Deloitte’s approximately 244,000 professionals are committed to becoming the standard of excellence.

In France, Deloitte calls on diversified expertise to meet the challenges of its clients of all sizes from all industries - major multinationals, local micro-companies and medium-sized enterprises. With the expertise of its 10,300 professionals and partners, Deloitte is a leading player in audit, risk advisory, consulting, financial advisory, tax & legal and accounting, based on a multidisciplinary offering and a set of action principles attuned to the requirements of our environment.

© 2016 Deloitte Conseil. Une entité du réseau Deloitte