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Outside the black box

A guide to model risk



Tackling model risk



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Modelling can be a risky business. It aims to quantitatively predict an organisations' future state in order to improve risk management processes. Which is, of course, much easier said than done.

As a notoriously complex area, modelling relies on a number of highly technical calculations which are prone to mistakes. One miscalculation or incorrect parameter can lead to significant financial losses. An incorrect model can also provide inaccurate information, which can be used to inform key business decisions.

With such high stakes, adequate oversight is a must. But this isn't always easy. The 'black box' environment in which modelling typically exists, makes it very difficult for an independent third party to understand. As a result, it is difficult for anyone outside the development team to offer meaningful challenge or assurance.

But it is important to gain that assurance over your models. Strong governance is essential and firms should understand that models are not static. Not only are they time limited by design, but they have a distinct lifecycle which should be closely monitored.

As with any form of risk management, they must be continually assessed to check that the models remain relevant, and the assumptions, input and IT standards are still valid. The model must be managed on a long term basis, requiring skilled resource and ongoing oversight.

This level of oversight should be fully embedded within the firm's wider risk management processes at each line of defence. It can be a challenge to balance these elements and meet regulatory requirements in a cost effective way, but it is important that firms continue to strive to do so.

Why do models matter?

'Models are an attempt to replicate reality but they do not define reality.'

Institutions from across the financial services sector rely on models to demonstrate scenarios that could impact a broad range of factors including pricing, return on equity, balance sheet valuations, liquidity, capital and associated stress testing. Therefore model usage has significant financial consequences requiring robust governance and risk control frameworks. Regulators are increasingly focused on modelling, have issued regulatory guidance documents and have also performed a number of thematic reviews around model frameworks.

Operational risk and losses with models

Significant amounts of data, assumptions and complex mathematical formulae go into developing and running models. The input data and assumptions could change according to internal, market and economic conditions. Therefore models should not be viewed as immovable or infallible, and should be re-validated and re-calibrated throughout their lifecycle, otherwise significant financial issues can arise.

The sheer complexity of modelling has led to significant financial losses including:

- A large financial institution lost \$4.5 billion due to an incorrectly and hard-coded parametrised factor
- An international investment bank lost \$2.8 billion due to miscalibration of a single valuation factor
- A major US investment bank incurred losses of \$6.5 billion, partly due to a poorly calibrated risk management model

The case for managing model risk

In addition to the risk of a mathematical error, the risks around modelling are amplified by the fact that the skillset is extremely specialised, making independent review difficult and creating a 'black box' phenomena that only a few people understand. The dependency on such individuals, and the potentially negative financial consequences from modelling errors, reinforces the need for a transparent and effective governance framework to mitigate model risk.

Senior Managers Regime

In recent years, regulators have also increased expectations of senior executives to better understand all aspects of their functions, which can also impact a number of related Senior Manager Functions (SMFs). These SMFs would cross first, second and third line structures. Significant penalties could result from a poorly managed framework.



Models can be used to produce quantitative estimates of the business' future position, in a range of areas including:

- Capital and liquidity management
- Solvency II
- Leverage ratios
- Credit, market and operational risk
- Counterparty credit risk
- IFRS 9 loan provisioning
- Fundamental Review of the Trading Book (FRTB)
- The series of XVA calculations
- Independent Price Verification (IPV)
- Prudential Valuation (Pru Val)
- Collateral management and margining
- Value At Risk (VAR)
- Pricing
- Remuneration
- Algorithmic trading
- Stress testing
- Financial planning and forecasting

Meeting regulatory requirements

With a number of high profile losses resulting from poorly managed model risk, regulators around the world are tightening their grip on the use and governance of models. While the key messages are broadly similar, each regulator does have its own areas of focus and governance requirements.

Key regulations relevant to model risk management include:



US Federal Reserve (US) – ‘SR11-7 Guidance on Model Risk Management’ (April 2011) is supported by the Comprehensive Capital Analysis and Review framework (CCAR). CCAR requires an annual capital plan submission, including details of model inventory, methodology, validation, independence and assumptions.



European Central Bank (ECB) – ‘Guide to Internal Models’ (March 2018) is supported by the Targeted Review of Internal Models (TRIM), which assesses ECB regulated banks’ risk weighted asset (RWA) models. TRIM checks standards by ensuring models produced to assess that the same regulatory requirements yield the same results across all banks.

They also released a paper (June 2018) outlining pre-application best practice for model approval, non-material changes and extensions.



Prudential Regulatory Authority (UK) – ‘Model Risk Management Principles for Stress Testing’ (April 2018). Compliance with the guidance is checked through the Bank of England’s annual concurrent stress tests and the Supervisory Review and Evaluation Process (SREP). Firms must review their model risk management processes against CRD IV/CRR and proposed changes under CRD V/CRR II. [www](#)

They have also released a paper on the Bank of England’s policy on valuation capability to support resolvability.



EBA guidance – ‘Guidelines on Credit Institutions’ Credit Risk Management Practices and Accounting for Expected Credit Losses’ (May 2017) provides clear expectations on establishing a framework to measure expected credit losses for IFRS 9.



FCA Consultation Paper ‘Individual Accountability: Extending the Senior Managers and Certification Regime to all FCA Firms’ (UK, 2017). Under the extended SM&CR framework, Senior Managers are required to have full oversight over all models used within their organisation. In order to fulfil this remit, senior management can no longer allow a black box approach and must understand the intended use, limitations and risks associated with each model. The penalties for non-compliance are significant.



Basel Committee for Banking Supervision 239 (BCBS 239) ‘Principles for Effective Risk Data Aggregation and Risk Reporting’, January 2013 - BCBS 239 aims to address data governance at both entity and group level. While it initially targeted systemically important banks, it has had a proportionate roll out to a wider range of banks depending on the size, nature and complexity of business activities. Targeting risk data aggregation, it is important to model risk as it ensures the necessary data is available from across all areas of the business.



Embedding model risk into the three lines of defence

Organisations have struggled to meet regulatory expectations, partly due to a lack of guidance awareness and sometimes not having competent, independent teams to perform model validation. Thematically, many firms face similar challenges in maintaining a robust model risk framework, as outlined opposite.



Typical challenges in maintaining a robust model risk framework

Governance	Data	Documentation	Resources
<ul style="list-style-type: none"> • Validation is not independent and is ineffective • 'Black box' effect – the mathematical formulae applied is too complicated to challenge • Lack of understanding on the core assumptions • Lack of transparency on the limitations of the model • Lack of back testing 	<ul style="list-style-type: none"> • There is no data dictionary to identify all inputs • Data sources are not clearly defined or traced to source • Data owners are not identified to manage data quality • There is a significant use of proxies which are not representative of the data requirements 	<ul style="list-style-type: none"> • There is no model inventory to identify the complete set of models across the organisation • Documentation is not sufficient to recreate the model independently • Changes made to the model are not clearly documented or project managed • There is a lack of gap analysis against directives and regulations issued by regulators 	<ul style="list-style-type: none"> • A shortage of skilled staff • Roles and responsibilities between model developers, model implementers and data providers are not clearly defined • Complex off-shore and on-shore arrangements

How can these be mitigated across the three lines of defence?

Line of Defence	Governance	Data	Documentation	Resources
First line	<ul style="list-style-type: none"> • Compliance with the model risk policy and governance arrangements • Oversight of the model life cycle • Thorough testing programmes 	<ul style="list-style-type: none"> • Establish a data dictionary • Trace data to source • Identify data owners and report on data quality issues 	<ul style="list-style-type: none"> • Develop and maintain a model directory • Ensure model documentation allows it to be recreated independently • Document why the model is fit for purpose 	<ul style="list-style-type: none"> • Ensure modelling staff are appropriately qualified • Awareness of governance frameworks
Second line	<ul style="list-style-type: none"> • Up-to-date policies • Monitor compliance with the model risk policy • Ensure model validation by a qualified, independent team 	<ul style="list-style-type: none"> • Maintain standards and policies for data ownership and control – where possible, demonstrate standards meet regulatory guidelines • Ensure data continues to be reliable 	<ul style="list-style-type: none"> • Ensure a model inventory is complete • Establish model documentation guidelines • Change management guidelines 	<ul style="list-style-type: none"> • Assess the impact of any skills shortages and any equivalent first line development skills
Third line	<ul style="list-style-type: none"> • Develop a model review programme • Review management's assessment of model risk • Assess the effectiveness of the model validation team 	<ul style="list-style-type: none"> • Assess data lineage and data quality controls • Ensure data is clearly documented and adjustments are transparent 	<ul style="list-style-type: none"> • Test the completeness of the model inventory • Check model documentation is fit for purpose 	<ul style="list-style-type: none"> • Ensure there are skilled staff to offer meaningful challenge to developers and validators

Establishing an effective model risk framework

A governance framework, with adequate systems and controls will mitigate the risks inherent within the model. The following governance framework takes into account regulatory guidance on mitigating model risk.

There are two parts to the framework, as demonstrated below.

1 | The control environment

The control environment is established by:

- Defining the model risk appetite
- Identifying model ownership
- Implementing relevant policies
- Enforcing governance arrangements
- Defining model approval and validation processes
- Maintaining a model inventory and documentation
- Developing effective IT support/maintenance programmes



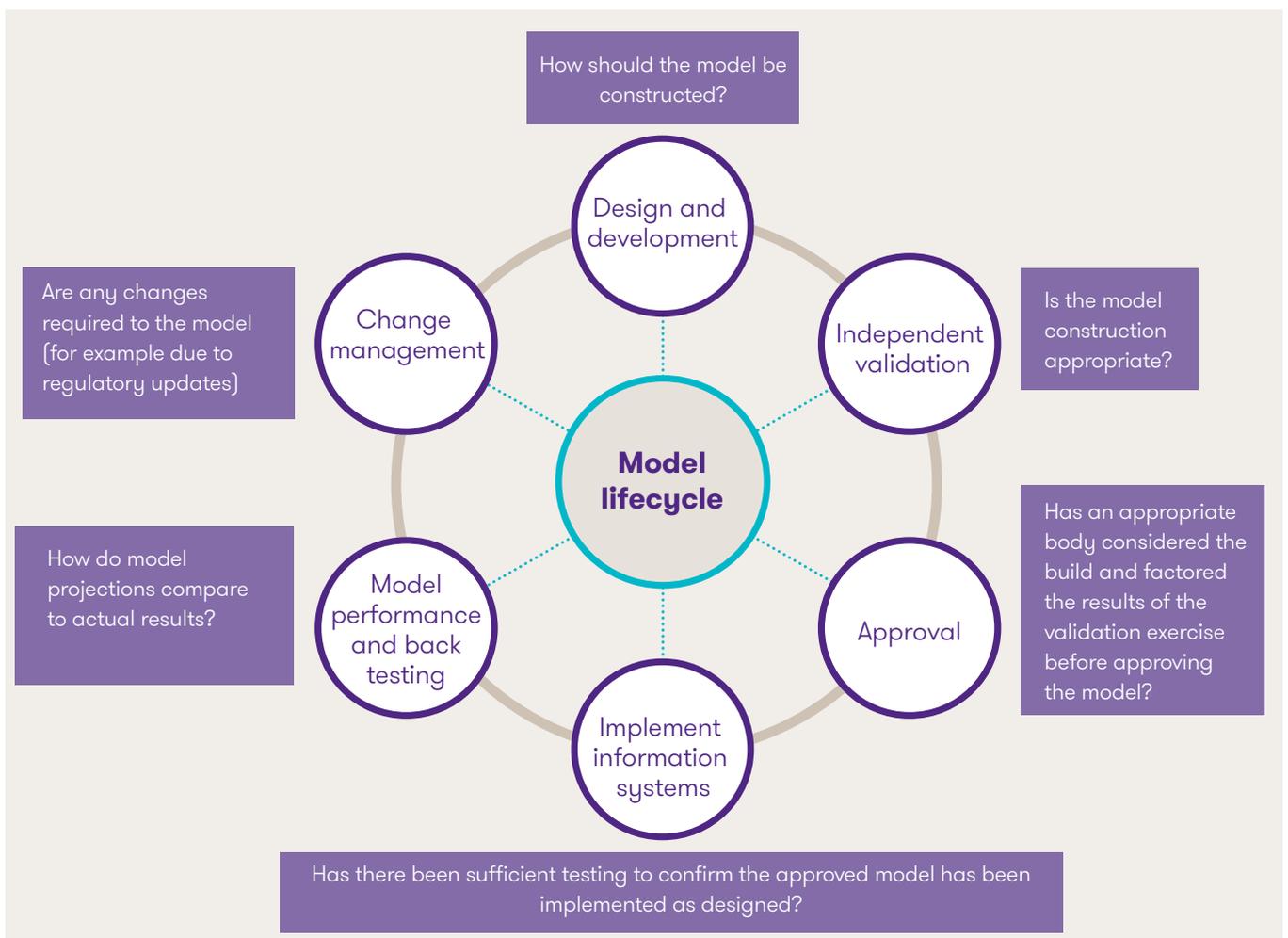
An effective model risk governance framework is supported by a robust control environment, which takes into account the evolving risks at each stage of the model lifecycle.

2 | The annual lifecycle

A model is an analogy, not a genuine depiction of an issue. It is built for a specific environment and is time limited.

As such, the model must continue to be tested and re-assessed throughout its lifecycle, on an annual basis.

When the environment it was designed for changes, the model stops being relevant and must be updated.



Gaining independent validation over the models

A key area of focus for the regulators

Independent model validation is the most important element of the model lifecycle and is subject to repeated emphasis by the regulators. Effective validation should challenge model development, implementation and purpose.



Independence

Independence is key to model validation. Specifically, model development and implementation should not be conducted by the same personnel. While regulators differ on the acceptable degree of overlap, typical processes are as follows:

- Most effective – two different teams and different reporting lines
- Partially effective – two different teams with a shared reporting line
- Least effective – separate staff within the same team

Firms must decide on the preferred approach depending on the scale of their business, the number of models applied and the skilled resources available.

What aspects of the model are typically subject to independent validation?

Data checks	<ul style="list-style-type: none">• Are data sources appropriate, complete, accurate and representative?• Is the data of good quality? Does it cover all variables?• Does data collection cause a bias?
Specification and performance	<ul style="list-style-type: none">• Is the methodology consistent with the model's purpose?• Does the model reflect all requirements? Are all assumptions justified?• How does the model perform against pre-defined tests and thresholds? Is there a process to report model breaches?
Documentation	<ul style="list-style-type: none">• Is the documentation detailed and comprehensive?• Can a sufficiently skilled modeller recreate the model based on the documentation?• Are model limitations clearly articulated?
Implementation and usage	<ul style="list-style-type: none">• Are appropriate governance arrangements and controls in place?• Are they compliant with frameworks, policies and internal standards?• Has model usage been integrated into day-to-day risk management?
Model approval	<ul style="list-style-type: none">• Have model validation findings been approved by the approval committee?• Have model validation recommendations been actioned?• If initial findings were material, has the model been revalidated?

How we can help

Our risk and finance experts have the necessary skills to assess your models and advise on your governance framework across the three lines of defence. Drawing on significant experience from across the financial sector, our model risk experts can help your management team understand your models and provide assurance that they are being used for the purpose for which they were intended.

We can help validate your models and offer technical assurance over the input data and controls, and can support your business in the following ways:

- Help to develop, or review the existing model risk management framework, including an appropriate model risk policy
- Offer assurance on the effectiveness of the model risk framework
- Provide skilled resource to validate or help validate models
- Establish a model inventory and advise on appropriate software to maintain it
- Review data lineage and controls of relevant data impacting models using the Basel guidance (BCBS 239)
- Support internal audit with model risk framework reviews, and deep-dives into individual models
- Assess relevant models against TRIM and CCAR standards
- Review overlaps between models used for IFRS 9 and Basel standards
- Assist in developing Basel models and seeking regulatory approval

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