



27 March 2017

Dear [Head of Stress Testing]

STRESS TEST MODEL MANAGEMENT

In the 2016 stress test results¹ the Bank communicated the intention to develop guidance for banks to support raising standards in stress test model development and management. This is set out in the annex to this letter. The guidance reflects the Bank's current thinking around principles of stress test model management.

The Bank considers good quality stress test models and processes as important since they underpin banks' stress test results. The board of directors and senior management of banks should not only aim to provide challenge to stress test model outputs but also understand the capabilities of stress test models, model limitations and the impact of model uncertainty on banks' stress test results.

The principles are relevant for all models used for concurrent stress testing including any material updates and revisions made to these models and any overlays made to model inputs, parameters and/or outputs to address known model limitations. Banks are encouraged to define, classify and manage other models used for internal stress testing as appropriate.

Objective of stress test model management

The primary objective of stress testing is to help regulators and banks assess capital positions under adverse economic conditions. The results of the Bank's concurrent stress test exercise help inform the setting of capital requirements for both macro and micro-prudential purposes. Banks are also increasingly using stress results to inform strategic and business decisions.

Stress testing models are designed to describe the financial and/or risk impacts of severe but plausible hypothetical tail scenarios based on real world or historical experiences. As they are used to assess the impact of tail risks and there is often limited data with which to build them, there is inherent uncertainty in their output. Not accounting for the uncertainty may lead to inappropriate use of stress test models or model errors. This can be mitigated to an extent by implementing an effective model management framework.

¹ *Stress testing the UK banking system: 2016 results*, November 2016, available at: www.bankofengland.co.uk/financialstability/Pages/fpc/stresstest.aspx.

The Bank's current thinking around stress test model management is centred around four key principles:

Principle 1 – Banks have an established definition of a stress test model and maintain a model inventory.

Principle 2 – Banks have implemented an effective governance framework, policies, procedures and controls to manage their model risk.

Principle 3 – Banks have implemented a robust model development and implementation process and ensure appropriate use of stress test models.

Principle 4 – Banks undertake appropriate model validation and independent review activities to ensure sound model performance and greater understanding of model uncertainties.

Next steps

The four principles provide transparency on the Bank's current thinking around expectations on stress test model management and are intended to support banks to assess their own stress test model management frameworks. As a first step the Bank will invite discussion and feedback from firms to ascertain how useful the principles have been in informing their stress testing model management processes and internal governance. The Bank will use this feedback to carry out further work to refine the principles on stress test model management. Should the Bank decide that adherence to the principles be set as a supervisory expectation it will consult in the usual way.

Yours sincerely

Director, Supervisory Risk Specialists, Bank of England

Annex – STRESS TEST MODEL MANAGEMENT PRINCIPLES

Principle 1 – Banks have an established definition of a stress test model and maintain a model inventory

P1.1. **Definition of a model:** Banks need to establish their own definition of a stress test model. When identifying stress test models banks are expected to take into consideration:

- a. calculation methods or systems that are based on statistical, financial or economic assumptions (eg stressed impairment models or stressed income models);
- b. calculation mechanisms used to transform a set of parameters or values into a quantitative measure used in the stress test process (eg scenario expansion models or stressed probability of default models);
- c. frameworks or systems where qualitative judgement is applied to generate quantitative stress results (eg where adjustments are made to address known model limitations); and
- d. calculations where outputs of other models are used to calculate financial/risk measures to describe a bank's financial/risk results during the stress period (eg expected loss under stress which uses the output of the stressed probability of default, loss given default and exposure at default models).¹

P1.2. **Model inventory:** Banks should maintain a comprehensive set of information on models 'implemented for use', 'under development', or 'recently retired'. The information should clearly identify model owners and users and should also include all model dependencies, ie stress test models that depend or use the output of other models. A designated internal party should be responsible for maintaining the bank-wide inventory of all models. Any variation of a model which requires separate validation and approval should be classified as a separate model.

Principle 2 – Banks have implemented an effective governance framework, policies, procedures and controls to manage their model risk

P2.1. **Board of directors and senior management responsibility:** The board of directors should establish a framework for the management of stress testing models and this should be adequately documented. Senior management is responsible for the execution and maintenance of the framework and should designate the roles and responsibilities for the framework to model owners, model users and control and compliance functions. The board of directors and senior management are expected to provide challenge to stress test model outputs and understand model capabilities, the model limitations, and the potential impact of model uncertainty on stress test results.

P2.2. **Model management policies:** Model management policies should cover all aspects of model management: including model definitions; model development standards; model change;

¹ While not all model validation standards may apply to simple calculations, eg out-of-sample testing or back testing, the calculations should nevertheless be subject to a rigorous control process and tested for accuracy of implementation.

implementation; use; validation; review; and management sign-off. The policies should set out appropriate governance and challenge frameworks and the roles and responsibilities of model owners, model users, and control and compliance functions. The prioritisation, scope and frequency of validation, review, and monitoring activities should also be set out in the policies.

- P2.3. **Model owners and control functions:** Model owners should have the accountability for model use and performance. Model owners should be responsible for ensuring that models are appropriately developed, implemented, used as intended and have undergone appropriate validation and approval. Control staff should have the authority to restrict the use of models and monitor any limits on model use.
- P2.4. **Role of Internal Audit (IA):** IA should be able to assess the overall effectiveness of the model management framework. IA should evaluate and independently verify whether model management practices are comprehensive, rigorous, and effective.
- P2.5. **Use of external resources:** If external resources are used for any model development, validation, or review activities, banks should be able to verify that that these are conducted in accordance with their model management standards. Designated internal staff should be responsible for the work delivered by the external party and should be able to address any issues identified either with model development or as a result of model validation.

Principle 3 – Banks have implemented a robust model development and implementation process and ensure appropriate use of stress test models

- P3.1. **Model purpose and design:** The purpose, design, choice of parameters, mathematical theory, and underlying assumptions of a model should be appropriately documented and conceptually sound (appropriate for the intended business purpose), and supported by published research and generally accepted industry practice. Particular emphasis should be placed on model limitations and where possible, model results should be supported by a comparison with alternative theories/approaches that are fit for purpose, or by assessing the sensitivities of changes in model inputs.
- P3.2. **Use of data:** The data used to develop a model should be assessed for quality and relevance. Where adjustments are made, proxies are used or where the data are not representative of the bank's portfolio or asset mix, the impact should be justified and documented so that users are aware of the potential model limitations.
- P3.3. **Testing:** Appropriate testing of models should be conducted to take into account potential limitations, assess their robustness and stability over time, and across a variety of economic and market conditions, in particular those relating to periods of stress. Testing activities should be appropriately documented.

- P3.4. **Documentation:** Banks should have sufficiently detailed model documentation so that an independent third party with relevant expertise should be able to understand how the model operates, identify its key assumptions and limitations and be able to replicate any parameter estimation and stress results. Where a bank uses vendor models, it should have appropriate documentation on the approach to be able to validate the model.
- P3.5. **Use of judgement:** Any judgements or model overlays that are used to modify the parameters, inputs and/or outputs of a model should form a part of the development process, should be appropriately understood and documented, and should be subject to review and challenge by independent parties.
- P3.6. **Supporting systems:** Model calculations should be implemented in information systems or environments which should have been thoroughly tested for this purpose. The findings of any system/implementation tests should be documented.
- P3.7. **Business involvement:** Frontline business should play an integral part in the design and testing of models and should challenge the methods, the underlying assumptions, and the output of the models-both at inception and on an ongoing basis.
- P3.8. **Model uncertainty:** Banks should demonstrate that the assessment of model uncertainties and inaccuracies are adequately understood and accounted for in the results presented to the model users. Where conservatism is used to account for model uncertainty, banks should justify and document any such adjustments and demonstrate that the adjustments are intuitive from a business and economic perspective.
- P3.9. **Monitoring:** Banks should perform periodic monitoring of their model performance with a frequency commensurate with the nature and materiality of the models and risks, with due consideration given to model complexity.

Principle 4 – Banks undertake appropriate model validation and independent review activities to ensure sound model performance and greater understanding of model uncertainties

- P4.1. **Scope of validation and review:** All model components (inputs, calculations, and reporting outputs) should be subject to independent validation for both in-house developed models and vendor models. Any validation work undertaken by model developers and users as well as any material changes to already validated models or overlays should be subject to review by an independent party. The extent of validation and independent review should be appropriate with the overall use, complexity and materiality of the models or changes to a model.
- P4.2. **Independence:** The staff performing model reviews should be independent of the model development process to be able to provide a robust and objective view. The effectiveness of the

independent challenge should be judged by the quality of the issues identified and the actions taken by model owners and management to address them.

- P4.3. **Staff competence and influence:** Banks should consider whether validation staff have the necessary knowledge, skills and expertise to perform model validations; an adequate degree of familiarity with the business, product, risk and intended use of the model; and sufficient influence and stature within the bank to ensure that issues and deficiencies are escalated and addressed in a timely manner.
- P4.4. **Treatment of model issues/deficiencies:** When significant model deficiencies and/or errors are identified during the validation process, banks should consider where the use of models should either be prohibited or only be permitted under strict controls and mitigants. The process of managing identified model issues should include the tracking of the outstanding issues and should be adequately documented.
- P4.5. **Frequency of model validation:** Banks should undertake regular re-validation of models to track known limitations and to identify potential new issues. Periodic reviews should be carried out with a frequency and level of rigour commensurate with the overall use, complexity and materiality of the models.