

Good practice guide

Quality assurance of models: a guide for audit committees



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For further information about the National Audit Office please contact:

National Audit Office
Press Office
157-197 Buckingham Palace Road
Victoria
London
SW1W 9SP

 020 7798 7400

 www.nao.org.uk

 @NAOorguk



Introduction

1 Government departments and agencies rely on models for their day-to-day activities including estimating costs; distributing funding within organisations; and testing policy options. They routinely develop and use models to generate insight into a question or to better understand a problem related to their business. These models can vary in complexity from relatively simple spreadsheets to detailed forecasts using specialist software. Outputs from models underpin decisions made by departments and arm's-length bodies that often have very real impacts on people's lives and can involve large amounts of money and resources. In recent years departments have used models to [*plan NHS test and trace services*](#), [*set allocations for teacher training places*](#), and [*estimate the cost of the financial settlement when leaving the EU*](#).

2 Errors in government models have directly caused significant losses of public money and delays to critical public programmes. Departments and public bodies need to have confidence that the modelling outputs they produce are reasonable, robust and used appropriately. Without an understanding of modelling-related risks, government plans will continue to be developed with weaknesses that place value for money at risk.

3 This guide aims to support audit committees in understanding and questioning the quality assurance of models and management of modelling-related risks. It draws on our 2022 [*Framework to Review Models*](#), a more detailed guide for people who commission analysis, provide analytical assurance and deliver the analysis itself. Both guides build on our work auditing models across government and the findings and recommendations from our 2022 report on [*Financial modelling in government*](#), and supplement existing government guidance and audit standards.

Why audit committees need to monitor modelling risks

4 Supported by the board, the accounting officer of each central government organisation is responsible for overseeing the use and quality assurance of models within that organisation. This expectation is set out in [*Managing Public Money*](#), HM Treasury's guidance on how to handle public funds.

5 As of 2021, there were nearly 1,000 business-critical models in use, across the 17 central government departments alone.¹ There is an important role for audit committees in understanding whether:

- an appropriate quality assurance framework is in place and used for all business-critical models, to support the management of modelling risks;
- there are processes in place to monitor quality-related modelling risks, provide visibility of these risks as appropriate and use this information to improve model quality assurance;
- the organisation is compliant with the expectations set out in modelling standards and guidance; and
- there are adequate resources with the required skills and capabilities to carry out these activities.

What we have found through our work

6 In our audit work across government, we continue to find weaknesses in models such as:

- limited or poor-quality data;
- unrealistic assumptions and optimism bias; and
- inadequate sensitivity and scenario analysis.

7 The centre of government and departments have worked together to improve understanding and oversight of models. Following the 2013 [*Macpherson Review*](#) of how government produces and uses models, HM Treasury updated *Managing Public Money* to provide detail on board and accounting officers' responsibilities for the quality assurance of models and set up the Quality Assurance Working Group to promote good practice across government. The [*Aqua Book*](#) is one of the working group's core products. Published in 2015, it introduced guidance across government on how to produce high-quality analysis.

¹ The HM Treasury Macpherson Review criteria for judging if a model is business-critical are based on the extent to which: the model drives essential financial and funding decisions; the model is essential to achievement of business plan actions and priorities; errors could engender serious financial, legal, or reputational damage or penalties.

8 However, although progress has been made, our 2022 report on *Financial modelling in government* found there remain significant weaknesses in how government produces and uses models. There is scope for better leadership from the centre of government to drive further progress, uphold standards and support greater transparency around models that departments use to make decisions. Although we saw examples of good practice, the level of quality assurance that departments apply to business-critical models remains variable. The analysis of uncertainty is often a peripheral activity despite it being extensively recommended in government guidance and despite the risks to long-term value for money of not doing so. Taken as a whole, the government is overly reliant on best estimates from models which do not fully reflect the inherent uncertainty and risks.



Our guidance

What this guidance covers

9 Our framework to review models (**Figure 1**) provides a structured and proportionate approach to reviewing models, which organisations can use to assess the risks relating to their models and determine whether the modelling outputs they produce are reasonable, robust and have a minimal likelihood of errors being made. It is split into eight stages starting with and driven by an initial assessment of risk, and is intended to support the reviewer in coming to an evidence-based judgement of the model and its outputs.

10 This guide draws out the key areas of our framework that audit committees may wish to consider when seeking assurance from management over the effectiveness of model risk management arrangements, to ensure that business-critical models are fit for use by decision-makers. These areas focus primarily on the governance, assurance and control arrangements for business-critical models.

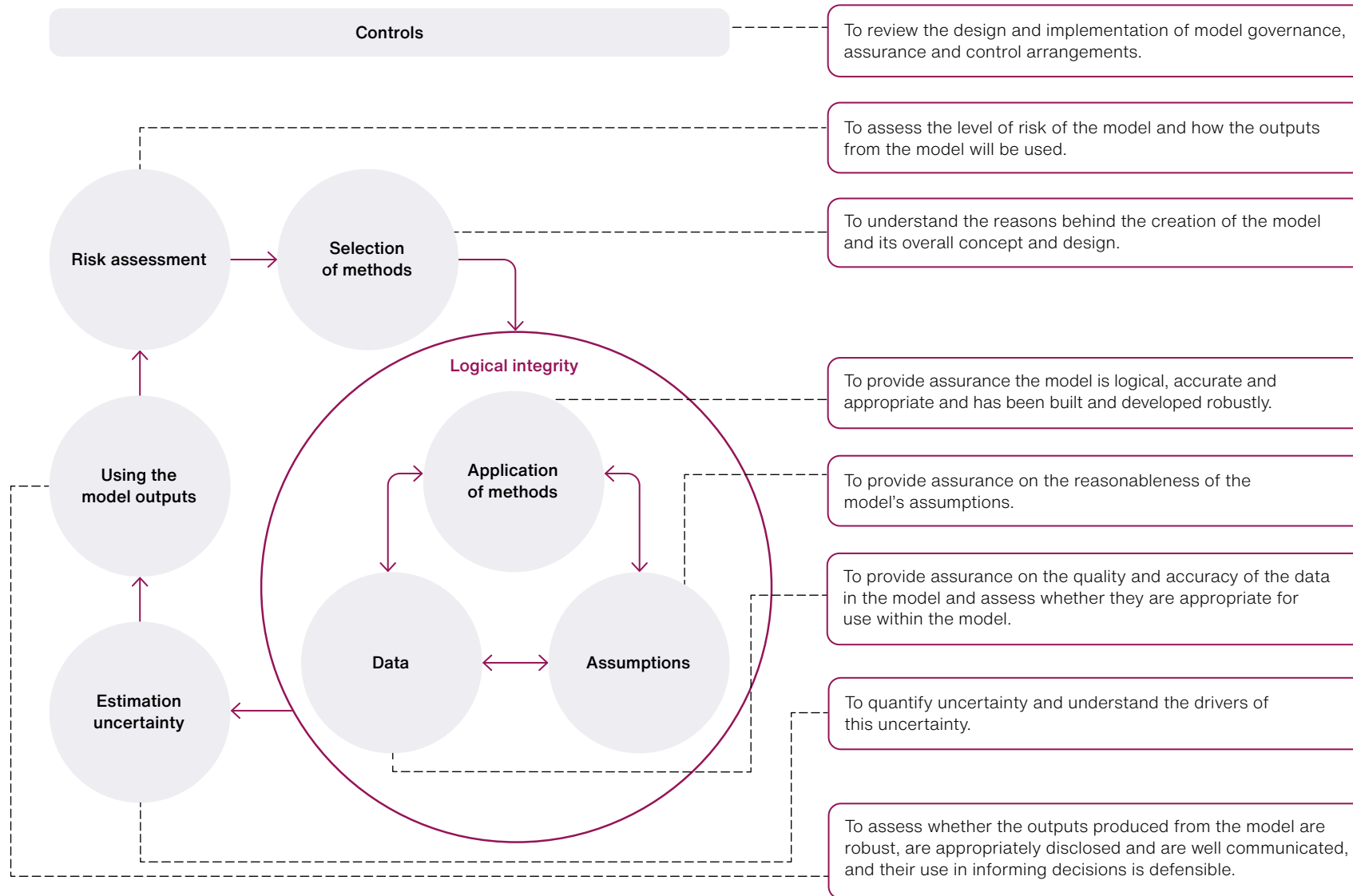
High-level questions

11 From our experience of auditing financial models across different parts of government, we think the following issues represent a good set of initial topics for consideration by audit committees when exploring the maturity of model quality assurance arrangements.

12 In each case, we have set out a high-level question and some aspects of what a good answer might look like, although these may vary by organisation. Overall, management should be able to describe an approach which considers people (culture, behaviours and skills), process, and governance to ensure a robust, proportionate and risk-based quality assurance environment.

Figure 1
The National Audit Office's framework to review models

We consider eight areas when reviewing government models



Source: National Audit Office, *Framework to review models*, January 2022

Question 1**13 Does the organisation have an appropriate quality assurance framework in place that is used to manage modelling risks for all business-critical models?**

- The organisation has a register of business-critical models that is regularly updated, based on a standardised approach to assessing a model's level of business criticality.
- The organisation has a proportionate and risk-based quality assurance framework defined for business-critical and other models. This should be actively implemented, with all models produced and assured in line with this internal guidance.
- The organisation actively monitors quality assurance activities and outputs, and uses this information to monitor risks and evaluate its plans to improve model quality assurance across the organisation. Risks and risk response plans are communicated to management and the board, as appropriate. This role is usually carried out by a dedicated central team.
- The organisation actively manages its resources to ensure staff with the right expertise are available to build, maintain and assure its business-critical models.
- The organisation has appointed a senior officer accountable for analysis (often called the chief analyst) who is accountable for the quality of analysis produced and ensuring analysis complies with government standards and guidance.

Question 2

14 Does the organisation ensure that all models are documented?

- All models should be documented. We find a well-documented model is usually an indication of a robust and fit-for-purpose model, as well as of a standardised approach to modelling across the organisation.
- Well-documented models will have at a minimum the following features documented:
 - specified roles and responsibilities such as the appointment of appropriate and named senior responsible owner (SRO) and analytical assurer;
 - concept and design of the model, including where the outputs of the model are used as inputs to another model;
 - technical guide for users;
 - version control log;
 - data and assumptions book;²
 - analytical assurance plan;
 - analytical assurance log;
 - model output reports;
 - proof of SRO sign-off; and
 - succession plan.

² Supporting guidance for the Aqua Book explains that an assumption may be a number, such as a projected data point or technology parameter, or a methodological assumption, such as a method for extrapolation. We also sometimes see assumptions in the form of adjustments or overlays made to the model outputs outside the core modelling environment.

Question 3

15 Does the organisation ensure that all business-critical models are subjected to appropriate scrutiny and challenge?

- There is an SRO for each model who is active in overseeing the model.
- For models with multiple stakeholders, there is an inclusive group in place and actively used by all relevant stakeholders to challenge the development and use of model output.
- Models are subject to appropriate independent analytical assurance, by assurers with the required specialist skills. A lack of independent review increases the likelihood that a model is not fit for purpose or contains errors.
- The organisation has a clear policy on publishing a model's methodology, data, assumptions or outputs, where appropriate. Transparency is important for facilitating scrutiny and challenge from Parliament and the public, and *Managing Public Money* states that transparency should be the norm in the development and use of all models.
- Significant assumptions used in models are routinely tested with experts, including external stakeholders.

Question 4

16 Does the organisation communicate the limitations of modelled outputs adequately to users, as standard?

- All models have limitations. These should be presented to users alongside the model outputs; for example, in business cases, ministerial submissions or disclosed as part of an organisation's Annual Report and Accounts or other published materials.

Question 5

17 Is uncertainty assessed and adequately communicated to users, and then used in making plans?

- The analysis of uncertainty should be routinely integrated into the presentation of model outputs. This might reasonably include:
 - discussion of which assumptions are most significant to the model output, based on sensitivity analysis;
 - a range consisting of high and low scenarios around a model's central output;
 - stress-testing against severe but plausible scenarios;
 - an assessment of confidence in the model's output; and
 - a discussion of unquantified uncertainties and their implications.
- Users of model outputs should consider and plan against the full range of plausible outcomes. We have found that the government is overly reliant on best estimates from models. It is important that model outputs fully reflect the inherent uncertainty and risks, and that decisions or plans that are based on these outputs include options against a range of outcomes.
- Contingency arrangements for high-impact outcomes or risks should be built into decisions or plans.

More detailed areas to explore

18 Our *Framework to review models* sets out a series of more detailed questions that audit committees may wish to ask management in order to gain assurance that effective controls are in place to manage modelling risk.

19 As part of its assessment, an audit committee should consider the quality of the evidence underpinning the assurances provided by management, including whether there is good evidence that the model quality assurance framework and policies are well designed, consistently implemented, and operating effectively with an appropriate compliance regime, in all relevant areas of the business.



Further resources

Below is a selection of guidance and insights that may be useful.

Government guidance

- HM Treasury's [*Review of quality assurance of Government analytical models*](#) (2013)
- HM Treasury's [*Aqua Book*](#)
- The Department for Energy Security & Net Zero (DESNZ) and Department for Business, Energy & Industrial Strategy (BEIS) [*Modelling Quality Assurance tools and guidance*](#)
- HM Government's [*Government Functional Standard GovS 010: Analysis*](#)
- Office for Statistics Regulation [*Quality Assurance of Administrative Data*](#)
- The government's [*Uncertainty Toolkit for Analysts in Government*](#)

Audit standards

- Financial Reporting Council, [*International Standard on Auditing 540 auditing accounting estimates, including fair value accounting estimates, and related disclosures*](#)

National Audit Office (NAO) work on model quality assurance

- [*Financial modelling in government*](#) (2022)
- [*Framework to review models*](#)

Other relevant NAO work

- [*Audit and Risk Assurance Committee effectiveness tool*](#)

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