FMSB
FINANCIAL MARKETS STANDARDS BOARD

Statement of Good Practice

for the application of a model risk management framework to electronic trading algorithms

Introduction

Financial Markets Standards Board

Financial Markets Standards Board ("FMSB") was established in 2015 in light of the recommendations of the Fair and Effective Markets Review in the UK with a mandate to issue Standards designed to improve conduct and raise standards in wholesale financial markets. FMSB has built up a body of Standards ("Standards") and Statements of Good Practice ("SoGPs") over time, prioritising those areas where FMSB member firms ("Member Firms") consider there is a lack of clarity in the standards of behaviour expected of market participants, or a lack of understanding of the issues relevant to a product or transaction type, or evidence of poor conduct.

Applicability of FMSB Statements of Good Practice (SoGP)

SoGPs are issued by FMSB from time to time. SoGPs do not form part of FMSB Standards, and they are not subject to FMSB's adherence framework. Rather, they reflect FMSB's view of what constitutes good or best practice in the areas covered by the SoGPs in question. Member Firms are expected, and other firms are invited, to consider their own practices in light of the relevant SoGP and make any changes to such practices that they deem to be appropriate. Failing to do so will not, however, create any presumption or implication that a firm has failed to meet its regulatory or other obligations.

Full details of the Member Firms are available at https://fmsb.com/. SoGPs will be shared with non-member firms and their affiliates, who are encouraged to consider them. Information on SoGPs will be made available to users of the wholesale markets (e.g., corporates and end investors) so that they may be made aware of their existence and FMSB's expectation of market conduct. FMSB will, as part of its normal course of business, periodically review the applicability of its published SoGPs to ensure they are relevant and up-to-date for market conditions.

Relationship with law and regulation

FMSB Standards and SoGPs do not impose legal or regulatory obligations on Member Firms, nor do they take the place of regulation. In the event of any inconsistency, applicable law, rules, and regulation will prevail. In developing Standards and SoGPs, certain regulators may have commented on their drafting, alongside Member Firms and other bodies, such that the Standards and SoGPs, once finalised and published, are intended to represent an authoritative statement of global good practices and processes. However, they are not normally endorsed by regulators. Where they are endorsed by a regulator, that will be made clear on the face of the Standard or SoGP in question.

Relationship with other codes

Other Codes already exist in relation to certain markets, such as the FX Global Code, while others are in the process of being produced. Some overlap exists between the work of FMSB and such other bodies and FMSB will seek to ensure it adopts a consistent approach in cases of overlap wherever possible and will seek to avoid issuing a Standard or SoGP where the subject matter is already covered adequately by existing regulation, or a Code issued by another body. It may draw attention to Member Firms of an existing code and request that Member Firms act in a manner consistent with it once appropriate steps have been taken to confirm its applicability.

I. Explanation

1. Purpose

1.1 The purpose of this SoGP is to support firms in applying model risk management frameworks in a proportionate manner to models deployed in their electronic trading algorithms ('Algos') taking into account the nature, scale and complexity of such models as well as existing systems and risk controls intended to mitigate associated market, conduct, credit and operational risks.

1.2 This SoGP addresses a sub-set of issues associated with model risk management and is not intended to detail a comprehensive model risk management framework or to address all risk types. The areas focused on are where market practitioners, including "first line" risk owners and "second line" risk managers, have identified that the nature of model use in electronic trading algorithms merits a differentiated approach compared with other model types. In particular, the SoGP considers:

i. Key factors in determining if a method used in an Algo constitutes a model (GPS 1);

ii. Factors influencing the risk-tiering assigned to a model used in Algos, and the impact of mitigating controls in reducing the residual risk of a model (GPS 2);

iii. Key features of model testing for Algos (GPS 3);

iv. Tailoring model risk management activities for models deployed in Algos to the context and purpose for which models are deployed, focusing on model methodology and input accuracy, staffing and ongoing performance monitoring of outputs (GPSs 4-7); and

v. The treatment of material changes to models deployed in Algos from a validation and documentation perspective (GPSs 8-9).

2. Scope and applicability

2.1 This SoGP applies to participants in wholesale financial markets that operate electronic trading algorithms involving the use of models (within the meaning set out in Section II. paragraph 2.1 below). Firms should continue to ensure compliance with any relevant supervisory guidance on model risk management as well as applicable organisational or other requirements when engaging in algorithmic trading.

2.2 In addition to the model risk management guidance set out below, in many jurisdictions firms will be subject to specific organisational requirements that are applicable where they engage in algorithmic trading[1]. These requirements include obligations on firms regarding the testing and deployment of algorithms, post-deployment management and means to ensure resilience (e.g., kill functionality, automated surveillance, business continuity arrangements and controls). This SoGP does not seek to reiterate these requirements unless they are of direct relevance to Algo model risk management frameworks.

[1] See for example Commission Delegated Regulation (EU) 2017/589 ('RTS 6') and the Prudential Regulatory Authority's Supervisory Statement 5/18

II. Model risk management frameworks

1. Regulatory context

1.1 The shortcomings of Value-at-Risk (VaR) based methodologies for measuring and managing position taking risks were acutely revealed by the 2007/8 financial crisis. As the Turner Review, which set out the UK regulatory response to the global banking crisis, put it, VaR models 'ended up not containing risk, but providing false assurance that other prima facie indicators of increasing risk…could be safely ignored'.[2] As a result of these shortcomings, sophisticated modelling techniques used for calculating trading risk and required capital came under significant global regulatory scrutiny following the crisis.

1.2 In 2011, the Board of Governors of the Federal Reserve System and Office of the Comptroller of the Currency (the 'OCC') published Supervisory Guidance on Model Risk Management ('SR11-7'). The guidance seeks to address the 'possible adverse consequences of decisions based on models that are incorrect or misused' by providing 'comprehensive guidance for banks on effective model risk management'. The recommendations cover model development, implementation and use; independent model validation, comprising evaluation of conceptual soundness, ongoing monitoring and backtesting; and effective governance, policies and controls.

1.3 Since 2011, the use and complexity of models has continued to increase with corresponding increases in a firm's potential exposure to model risk. In light of this evolving landscape, the Prudential Regulation Authority ('PRA') in the UK has published a Supervisory Statement setting out model risk management principles for banks ('SS1/23'). The principles cover all elements of the model lifecycle[3] and are applicable to all types of models that are used to inform business decision making, risk management and reporting.

1.4 SR11-7 and SS1/23 apply to all models used by banks that meet the respective model definitions set out below. These publications and their associated guidance[4] do not explicitly refer to the use of models in algorithmic trading. However, methods, systems or approaches used in Algos that meet the definition remain subject to the guidance.

2. What is a model?

2.1 SR11-7 applies to any 'quantitative method, system or approach that applies statistical, economic, financial, or mathematical theories, techniques, and assumptions to process input data into quantitative estimates'[5] ('Model'). This captures a broad range of activities in which Models are used, including 'underwriting credits; valuing exposures, instruments and positions; measuring risk; managing and safeguarding client assets; determining capital and reserve adequacy; and many other activities [including]… enterprise-wide risk management'.[6]

2.2 Paragraph 2.4 of SS1/23 defines a model as 'quantitative method that applies statistical, economic, financial, or mathematical theories, techniques, and assumptions to process input

[2] The Turner Review, p22
[3] Para 1.4, SS1/23. The principles are effective as of 17 May 2024
[4] See OCC Model Risk Management Handbook, August 2021 (the 'OCC Handbook')
[5] SR11-7, p3
[6] SR11-7, p1

data into outputs'. SS1/23 states that input data can be quantitative and/or qualitative in nature or expert judgement-based and the output can be quantitative or qualitative. Paragraph 2.3 clarifies that models 'are a subset of quantitative methods' and the 'output of models are estimates, forecasts, predictions, or projections, which themselves could be the input data or parameters of other quantitative methods or models'. This model definition should be applied by PRA regulated firms[7].

2.3 Two elements of the SR11-7 Model definition are particularly instructive when considering if an Algo, or method used within an Algo, should be characterised as a Model: (i) if the output is a quantitative estimate; and (ii) if statistical, economic, financial, or mathematical theories, techniques or assumptions have been applied.

2.3.1 Quantitative estimate – if there is immaterial uncertainty in the Model output, for example due to the method processing data into an output that is observable or empirically verifiable based on real time (or near real time) data, it may not constitute an estimate; and

2.3.2 Application of statistical, economic, financial, or mathematical theories, techniques or assumptions – methods performing simplistic calculations or where the output is based on 'deterministic rules'[8] may not entail the application of theories, techniques or assumptions (see Example 1, Annex 1).

3. Model risk

3.1 Models are imperfect simplifications and approximations of reality meaning that a degree of uncertainty and inaccuracy is an inherent feature of any Model. However, model risk does not derive simply from the inevitably imperfect nature of a Model. Instead, it concerns the decisions that are based on such Model outputs[9]. The PRA in the UK's Policy Statement on Model Risk Management Principles for Stress Testing (PS7/18) emphasises the need for senior management and the board to possess a 'general understanding of the most material models, the uncertainty around judgements, where the model is expected to work well and in what circumstances it is likely to break down'.

3.2 SR11-7 defines model risk as 'the potential for adverse consequences from decisions based on incorrect or misused model outputs and reports' ('Model Risk').

3.3 The adverse consequences that Model Risk can lead to will vary depending on the Model, its application and the degree of reliance placed on it by the firm. Such consequences include 'financial loss, poor business and strategic decision making, or damage to a bank's reputation'[10]. In some instances, the adverse consequences could 'pose risks to the safety and soundness of firms and overall financial stability'[11].

3.4 Decisions based on:

3.4.1 Incorrect Model outputs and reports – this may derive, amongst others, from material errors in the methodology of the Model leading to it producing inaccurate or undesired outputs when compared against the design objectives and intended business uses.

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[7] This policy and embedded definition is effective as of 17 May 2024.
[8] OCC Handbook, p2
[9] See for example, Model use and misuse, David Rule, Bank of England, 14 May 2019
[10] Supra 6
[11] CP6/22, para 1.11

3.4.2 Misused Model outputs and reports – using a Model in scenarios where it is not appropriate or where Model limitations are not recognised or decisions are taken based on Model outputs without a sufficient understanding of the uncertainty around those outputs e.g., a Model designed to generate an estimate of a price for a liquid instrument being used to generate price estimates for illiquid instruments.

4. Model use in Algos

4.1 Algos are used in a wide variety of ways in wholesale financial markets, with new uses and applications emerging over time. Examples include:

4.1.1 Assisting in the execution of trades either as principal or agent e.g., by determining the price of an instrument or the venue on which bids and offers are submitted;

4.1.2 Calculating client request-to-trade ratios.

4.2 Models may be used to inform how Algos make trading and pricing decisions referred to above. An Algo itself may constitute a Model or a Model be a component of an Algo.

4.3 Feeder Models are often used in Algos to calculate inputs for other Models. When using feeder Models in Algos, firms will typically consider how to: (i) ensure that the validation of such Models is proportionate to, and focuses on the reduction or mitigation of risks associated with, their use; and (ii) reflect the use of feeder Models as inputs into other Models for the purposes of Model documentation.

5. Factors influencing the degree of Model Risk

5.1 Several factors influence the degree of Model Risk and the potential magnitude of any adverse consequences. Some of these factors, and their application to Models used in Algos where they are materially different to other Model types, are considered below.

5.1.1 Model complexity – the increasing complexity of Models typically increases firms' potential exposure to Model risk.

5.1.2 Degree of uncertainty about Model inputs or assumptions – higher uncertainty about Model inputs or assumptions typically increases firms' potential exposure to Model Risk.

5.1.3 Degree of criticality of the Model to the firm or its clients – greater reliance on Model outputs increases Model Risk.

5.1.4 Intended applications – the nature and magnitude of adverse consequences deriving from Model use will vary according to how a Model is applied as well as how frequently it is used. For example, the potential adverse consequences deriving from Models used to inform pricing of RFQs (request for quote) will differ from Models deployed to support risk management decisions.

5.1.5 Back-testing – Models used in Algos often benefit from the availability of large data sets which can be used to statistically demonstrate that a Model is acting in accordance with the design objectives and business uses. In other contexts, the ability to use back-testing can be limited due to lack of data or of price observability.

5.1.6 Duration of uncertainty of the estimation – longer duration of uncertainty of a quantitative estimation deriving from a Model output increases a firms' potential exposure to Model Risk. In algorithmic trading, the period for which an estimation is uncertain is often shorter than other Model types as the time between the use of the Model (e.g., to price an instrument) and the risk being realised (e.g., a trade being agreed) is typically short. Conversely, rapid recycling of risk in an Algo context means that many trades can be agreed in a short timeframe.

5.1.7 Frequency of change and review - Models used in Algos may be subject to increased implementation errors with increased frequency of code changes. Conversely, they are usually subject to frequent review and refinement meaning that any issues associated with a Model post-implementation are quickly identified.

5.1.8 Control frameworks – the efficacy of existing risk management frameworks intended to mitigate conduct, market, credit and operational risks. Effective holistic risk management frameworks can mitigate the adverse consequences of using Models, including where the systems or risk controls are not specifically intended to mitigate Model Risk.

In an Algo context, Model Risk may be reduced or mitigated both by (i) controls embedded within the logic of the Model such as upper and lower boundary checks on an input parameter; and (ii) the application of all other associated controls applied outside the Model. Such controls may include:

5.1.8.1 controls on Model inputs

5.1.8.2 controls applied to the Algo or Algo trading system that ensure quantitative outputs (e.g., prices) are within certain minimum and maximum values

5.1.8.3 pre-defined limits on:

i. number of instruments being traded

ii. price, value and number of orders

iii. number of venues to which orders are sent.

5.1.8.4 manual trading supervision of the Algos

These controls can significantly mitigate Model Risk for Algos by preventing or reducing adverse consequences of decisions based on the Model. For example, price collars and pre-defined limits implemented within the model can reduce the impact of Model inaccuracy by restricting the outputs to marginal price differences at which a trade can be executed through automatically blocking or cancelling orders that do not meet set price parameters.

5.2 The factors discussed in Section 5.1 can differentiate the nature and magnitude of risks present in using Models in an Algo context compared with other Model uses and mean that a proportionate and tailored application of model risk management frameworks is necessary.

6. Algorithmic trading risk summary (‘Key Risk Summary’)

The table below summarises material risks associated with the deployment of Algos either to fair and effective markets or to Algo operators. The table encapsulates conduct, market, credit, operational and Model Risks. A firm’s risk management frameworks, of which a model risk management framework is one component, will typically be designed to reduce or mitigate such risks, though appropriate calibration and effective application of such frameworks will be key to their effectiveness.

Risk category	Risk description	Drivers	Risk Mitigants
Risks to fair and effective markets / Risk to clients or counterparty	• Market abuse (including front running) or violation of rules of a venue • Pricing that is materially inconsistent with the current market price • Trading off-market • Flash crash • Quote overload • Absence of service • System resilience risk	• Design of Algo • Inaccurate, incomplete or unavailable market data • Bug in the Algo implementation • Algo unavailability • Technology failures • Unavailability of key individuals with understanding of the Algo • Unexpected behaviour from controls or bug in control logic implementation • Change errors and release management • Inability to kill Algo functionality • Incorrect interpretation or inappropriate use of outputs	• Controls on order entry - Maximum order values and volumes - Maximum message limits • Risk limits on: - Market risk - Credit risk • Change management controls such as: - Testing (including consideration of data and inputs, potential conduct risks) - Implementation review - Independent review from risk stewards • Documentation • Staff expertise, training and development • Business performance monitoring • System capacity and connectivity monitoring • Surveillance
Risk to Algo operator	• Trading off-market • Significant financial loss • Ineffective controls/limits • Inappropriate change management processes		

Glossary

Term	Definition
Electronic Trading Algorithm / Algo	A computer algorithm that automatically determines individual parameters of orders or quotes such as whether to initiate the order, the timing, price or quantity of the order or how to manage the order after its submission, with limited or no human intervention.
Inherent Risk	The risk resulting from the usage of a Model taking into account any controls embedded within the logic of the Model.
Mitigating Controls	Any controls in place that reduce or restrict the Inherent Risk of the Model[12].
Model	A quantitative method that applies statistical, economic, financial, or mathematical theories, techniques, and assumptions to process input data into quantitative estimates[13].
Model Risk	The potential for adverse consequences from decisions based on incorrect or misused Model outputs and reports.
Residual Risk	The risk remaining having applied all Mitigating Controls to the Inherent Risk.

[12] Mitigating Controls include any Algo trading controls. Pursuant to Principle 1.3 of SS1/23, the definition excludes model risk management controls set out in the Good Practice Statements that are intended to further reduce risk through effective model risk management. Residual Risk is therefore determined absent of such model risk management controls.

[13] When applying this definition, in addition to 'quantitative estimates', PRA-regulated firms should also include outputs that are qualitative in nature, as set out in Section II, paragraph 2.2.

III. Good Practice Statements

This SoGP sets out nine GPSs relevant to the application of a model risk management framework to Algos. Firms should continue to apply any supervisory expectations and relevant guidance applicable to them and their Models. The Principles are intended to supplement and assist firms with the practical application of these expectations and guidance for Models used in Algos in a manner that is commensurate with the risks posed by such Models.

1. Model identification

Good Practice Statement 1:

Firms should examine their Algos to identify any methods that constitute a Model.

Commentary

Firms should use the definition set out in Section II, paragraph 2.1 or, where applicable, paragraph 2.2 when determining if a method used in an Algo constitutes a Model. When making this determination for Algos, firms should consider if the method output is a quantitative estimate and if it entails the application of statistical, economic, financial, or mathematical theories, techniques or assumptions (see Section II, paragraph 2.3).

These considerations may lead a firm to conclude that a method used within an Algo is not a Model. Where a firm determines that a method does not constitute a Model but such method (i) has a material bearing on business decisions made by one or more Algos; and (ii) is complex in nature, the firm should consider whether to apply relevant parts of GPSs 2-9 outlined in this SoGP.

Firms should maintain a mapping between their Algos and associated Models (i.e., the Algos, or components of Algos, that are classified as Models).

2. Model Risk tiers

Good Practice Statement 2:

Firms should categorise each of their Models associated with Algos into risk-based tiers to help identify and manage Model Risk.

Commentary

Each Model should be categorised into a risk-based tier that reflects the materiality of the risk presented by the Model and its potential impact on the fair and effective operation of markets or the Algo operator.

When categorising a Model into risk-based tiers, firms should consider:

- the material risks presented by the Algo using the Model (for example, by considering the risks described in the Key Risk Summary)
- in relation to the Model, the:
  - risk resulting from the usage of a Model ('Inherent Risk')
  - risk remaining having applied all Mitigating Controls to the Inherent Risk ('Residual Risk')
- key factors influencing the degree of Model Risk (see Section II, paragraph 5.1),

including:

- degree of uncertainty about Model outputs;
- Model complexity;
- criticality of the Model to the firm or its clients;
- speed and frequency of objective feedback on the performance of the Model;
- the additional risk incurred resulting from operating a Model compared with a calculation that does not meet the definition of a Model; and
- the intended applications of the Model, including its scale, and how the output is utilised in an Algo.

Model testing, validation, governance and documentation requirements should take a Model's risk-based tier into account, the materiality of any changes, and be applied in a manner proportionate to the risks posed by such Model.

3. Model testing

Good Practice Statement 3:

Model testing in Algos should, in particular:

i. Assess Model performance under a variety of market conditions, including volatile conditions and scenarios where there is limited and/or poor quality market data; and

ii. Emphasise the importance of testing both the controls embedded within the logic of the Model and the Mitigating Controls in addition to testing the accuracy of a Model.

Commentary

Testing in this context is intended to demonstrate that a Model is performing as intended: that it does not behave in unexpected manners, contribute to disorderly trading conditions, or deviate from regulations or trading venues' systems. The nature of testing and analysis depends on the type of Model and its applications. Firms should seek to achieve an appropriate balance between testing both the controls within the logic of the Model and any Mitigating Controls, with testing Model accuracy.

4. Model validation

Good Practice Statement 4:

When considering the Residual Risk and the depth and frequency of the validation of the methodology of a Model used in Algos, firms should take into account all Mitigating Controls.

Commentary

Model validation is the set of processes and activities intended to verify that Models are performing as expected, in line with their design objectives and business uses[14]. Effective Model validation can help reduce Model Risk by identifying Model errors, corrective actions and appropriate use as well as providing information about the source and extent of Model Risk.

[14] SR11-7, p9

Residual Risk can be significantly mitigated through the controls, pre-defined limits and trading supervision activities outlined in Section II, paragraph 5.1.8. Where there are such Mitigating Controls in place, these should be considered in the validation of the relevant Model. Validation should focus on ensuring the effectiveness of the Mitigating Controls in mitigating Model Risk.

Good Practice Statement 5:

Model validation activities should be tailored to the context in which such Models are deployed and proportionate to the risks they present. For Algos, Model validation may prioritise reliance upon the effectiveness of Mitigating Controls over Model accuracy.

Commentary When conducting Model validation for Models used in Algos and ensuring that such validation is commensurate with the risks these Models pose, firms should consider:

- Impact of accuracy – the potential adverse consequences deriving from Model inaccuracy in Algos can be significantly reduced by Mitigating Controls that limit the impact of sub-optimal Model outputs. Model validation for Algos may therefore place greater emphasis on Mitigating Controls and the context in which a Model is used rather than the accuracy of the Model.
- Back-testing – back-testing as part of Model development may reduce the extent of validation required as large data sets can often be used to statistically demonstrate that the Model is acting in accordance with the design objectives and business uses. However, the way in which the market may react to a new or updated Model may not be accurately reflected in back-testing results.
- Duration of uncertainty of the estimation - the period for which an estimation is uncertain in an Algo context is often shorter than for other Model types. Furthermore, Algos are typically subject to more frequent review and refinement meaning that any issues from Model inaccuracy are identified quickly (see Section 5.1.6 and 5.1.7). However, even where the period of uncertainty is limited, firms should consider if any adverse consequences could be compounded by multiple issues arising in a short time period.
- Innovation - there is significant diversity of Models associated with Algos due to their innovative development. The market derives benefits from such innovation and experimentation. The resulting absence of standard benchmark Models means that benchmarking comparisons of Model methodologies may be of limited value in reducing the risks associated with operating Algos.

Staffing

Good Practice Statement 6:

Independent staff conducting Model validation for Models associated with Algos should be sufficiently knowledgeable of the use of such Models in financial markets.

Commentary When staffing Model validation activities in an Algo context firms should consider the following:

- Independence – validation should be conducted by staff who are not responsible for the development or use of the Model and do not have a stake in whether it is determined to be valid.
- Expertise – staff conducting each element of the validation should be sufficiently knowledgeable about the Model use in financial markets. This could be achieved through dividing validation between different groups of independent staff.
- Duplication - where elements of Model validation are performed by independent

staff as part of existing control and risk management frameworks, this validation should be considered as part of Model validation. Duplication of validation activity should be avoided unless it is justified by the mitigation of specifically identified risks.

Ongoing performance monitoring of Models used in Algos

Good Practice Statement 7:

The nature and frequency of ongoing performance monitoring for Models associated with Algos should (i) be appropriate to the risk-based tier of the Model; and (ii) complement any manual trading supervision of the Algos and the associated continuous objective feedback of Algo or Model performance required in a wholesale markets context.

When considering how to respond to any Model issues or errors identified during ongoing performance monitoring, firms should consider, using observed data, if such issue or error is likely to lead to materially adverse outcomes.

Commentary

Ongoing performance monitoring of Models used in Algos is intended to confirm that a Model has been appropriately implemented and is being used and performing as intended.

Monitoring metrics

The identification of appropriate ongoing performance monitoring metrics for Models requires qualitative professional judgement and detailed understanding of the relevant market and instrument as well as the intended applications of such Models and their risk-based tier. Firms may consider whether it is appropriate to use existing algorithmic trading monitoring for the purposes of monitoring Model Risk.

Responding to Model issues / errors

Setting monitoring thresholds for Models, which determine the point at which a performance indicator needs to be investigated, will require qualitative professional judgement, and should place greater focus on identifying realised material adverse impact of issues and less on theoretical Model accuracy or revenue optimisation.

When determining how to respond to a Model monitoring threshold being triggered, firms should take into account factors including:

- the nature of the metric and threshold trigger (e.g., the threshold may have been triggered by adverse market conditions as opposed to an issue or error with the Model);
- the magnitude of any adverse consequences deriving from the issue or error identified;
- the probability of such consequences materialising;
- commercial considerations such as the viability of rebuilding the Model to address the issue or error; and/or
- whether the relevant metrics or thresholds remain appropriate.

5. Model changes

Validation of Model changes

Good Practice Statement 8:

When determining if a change to a Model associated with Algos requires validation, and, if so, the extent of such validation, a firm should consider (i) the materiality of the change in methodology; (ii) the risk-based tier of the Model; (iii) the extent to which the change impacts the Inherent Risk of the Model.

Commentary

Firms should develop clear procedures and guidelines on what constitutes a material Algo Model change.

When determining which Algo Model changes require validation and the extent and timing of such validation, firms should consider:

- the degree of change in methodology
- the risk-based tier of the Model
- the effectiveness of existing controls – the presence of a robust review and control framework may lead to a professional judgement that a particular change does not require validation prior to release and that the change will be captured in the next periodic revalidation. For example, a simple functional logic change may be deemed not to require validation, unless there is a potential for significant negative impact on the performance monitoring of the Model
- any previously validated testing, controls review and performance monitoring reviews associated with the Model
- if the change is required to respond to market changes effectively and expeditiously. In such instances firms may deem a retrospective validation of the change appropriate in accordance with their governance structure and applicable policies and procedures. Any resulting risk may be managed by assessing that the change does not result in a materially adverse impact or compromise the Mitigating Controls. Retrospective review and validation is subject to regulatory requirements applicable to the management of 'material' changes[15].

[15] See, for example, Article 11, RTS 6

Documentation of Model changes

Good Practice Statement 9:

Firms should consider whether Model, or Model change, documentation can be supported with Model source code access.

Commentary

Documentation of Model development and validation should be sufficiently detailed so that parties unfamiliar with a Model can understand the Model's purpose, how it operates; its limitations and key assumptions; and how it was validated.[16] Firms should consider the most appropriate way of presenting such information, given the potential for more frequent changes to Models used in Algos relative to other Model types. It is not necessary for Model documentation to be comprehensive to the point where the Model can be replicated without reference to its source code.

Relevant considerations when determining the degree of detail in Model documentation for Algos include the:

- Inherent and Residual Risk of a Model
- frequency and nature of any changes to a Model
- confidential nature of a Model and any additional information security protection surrounding the code.

To facilitate an independent Model Risk validation or expedited change review, firms may elect to supplement Model documentation with access to the source code underlying a Model.

[16] SR11-7, p24

Annex 1

Examples of applying a model risk management framework to Algos

Set out below are illustrative and non-exhaustive examples of the application of certain Good Practice Statements. The examples are stylised and should not be understood, or interpreted, as precise rules or prescriptive and comprehensive guidance.

	Example	Assessment against GPSs	Rationale
1	Firm X is deploying a suite of Algos and examines the methods used to determine if any should be classified as Models. Method A utilises complex statistical and mathematical theories to produce a quantitative estimate of the mid-price of an instrument. Method A is identified as a Model. Method B performs a simple exponential weighted moving average of prices on a trading venue to estimate the mid-price for an instrument on the trading venue. Method B is not identified as a Model.	Consistent with GPS 1 ✓	Firm X has appropriately examined the suite of Algos. Method A is appropriately classified as a Model on the basis that it is using statistical and mathematical theories to produce a quantitative estimate. Model B is considered not to involve the use of statistical, financial, or mathematical theories, techniques or assumptions and therefore is not classified as a Model even though it produces an estimate.
2	Firm Y deploys an Algo that contains a method that utilises statistical and mathematical theories to estimate the mid-price of an instrument. Firm Y has implemented a high-quality control framework around their Algos and so determines that identifying the method as a Model and implementing a Model Risk management framework is unnecessary.	Inconsistent with GPS 1 ✗	The method in this case should still be identified as a Model as it involves the application of a mathematical theory to generate a quantitative estimate. The wider Algo control framework should be considered as Mitigating Controls relevant to the overall risks posed by the Model or the Algo.

	Example	Assessment against GPSs	Rationale
3	Firm Z has an Algo that utilises statistical and mathematical theories and is responsible for streaming prices in a high-volume instrument for which the firm has significant market share. • the Algo is identified as a Model; and • the Model is considered to have high Inherent Risk. The firm has implemented robust Mitigating Controls around the prices produced by the Algo. As a result, the firm determines that the Model has low Residual Risk and allocates it into a low risk-based tier. The Model validation and governance activities focus on ensuring the effectiveness of all the Mitigating Controls. Given that robust Mitigating Controls have been implemented, the firm considers that any inaccuracy of the Model would not result in material risk to the firm, counterparties, or the market. The validation of the methodology and accuracy of the Model is therefore limited. Validation instead focuses on ensuring the effectiveness of the Mitigating Controls.	Consistent with GPSs 2, 4 and 5 ✓	Firm Z has categorised the Model into an appropriate risk-based tier following an assessment of the Model's Inherent and Residual Risk and Mitigating Controls. Firm Z has focused on ensuring the effectiveness of its Mitigating Controls given the importance of such controls in mitigating the risk of the Model.

	Example	Assessment against GPSs	Rationale
4	Firm A identifies that a method utilised by one of its Algos is a Model. The Model utilises statistical and mathematical theories and is responsible for estimating a parameter used by the Algo to stream prices in a high-volume instrument for which the firm has significant market share. Firm A determines that the Model has high Inherent Risk. Firm A has implemented Mitigating Controls, including those restricting the prices produced by the Algo to minimum and maximum values. As these controls operate outside the immediate scope of the Model, they are not considered in the determination of the Residual Risk of the Model. Firm A determines that the Model has high Residual Risk. Firm A classifies the Model into a high risk-based tier. Extensive Model Risk validation and governance activities are conducted due to the high Inherent and Residual risk determinations. In particular, an in-depth validation of the Model's methodology and accuracy is conducted including the independent development of challenger Models to assess whether an alternative methodology might increase the accuracy of the Model.	Procedural steps taken are not required by GPSs 2,4 and 5 –	Firm A has not considered all Mitigating Controls in determining the Residual Risk of the Model. Firm A's in-depth validation of the Model's methodology and accuracy may not be a proportionate or appropriate use of resources given the risk profile of the Model.

	Example	Assessment against GPSs	Rationale
5	Firm B has Model performance monitoring thresholds based on Model accuracy. During a recent market dislocation event, these thresholds were triggered for a specific Model. This event did not result in material revenue loss, customer detriment, market impact or breach risk appetite. Firm B conducts a review to determine how to respond to the Model monitoring threshold being triggered. When reviewing the Model performance monitoring outputs, Firm B focuses on the sub-optimal Model accuracy performance and does not consider if the Model exposed, or is likely to expose in the future, the firm, or the market to material adverse outcomes. As a result, a decision is taken to re-build the relevant Model. However, Firm B did not consider the commercial implications of such re-building, where the cost may be disproportionate to the risks posed.	Inconsistent with GPS 7 ❌	When setting the performance monitoring metrics for the Model, the firm focused on identifying optimal Model accuracy performance instead of material adverse impacts. When considering how to respond to the Model performance monitoring threshold being triggered Firm B did not consider the risk of material adverse outcomes deriving from the Model. The firm did not consider the commercial implications of re-building the Model.

	Example	Assessment against GPSs	Rationale
6	Following an unexpected removal of capital controls in jurisdiction Q, a currency that had previously traded in an illiquid and volatile way, starts trading in much greater volumes without the same extreme price moves. Firm C decides to expedite the roll-out of a change to the Model used in pricing the currency to improve risk management and client service. The Model has a high Inherent Risk rating based on both the complexity of the Model and Firm C's significant market share. The Model has a low Residual Risk rating based on the effectiveness of the Mitigating Controls and is assigned a corresponding low risk-based tier. Firm C considers that the change in the pricing for this currency could be material to the Model but would not constitute a substantial update to the Algo itself. The change should not impact the Inherent Risk of the Model. Additionally, the Mitigating Controls will not be impacted meaning the Residual Risk remains unchanged. The change is close to a pre-determined threshold set by Firm C, where re-validation is required. However, given the change to market conditions a review is conducted by a person designated by senior management who exercises qualitative professional judgement which concludes that there is a significant potential negative impact of waiting for additional validation. A decision is made, in accordance with Firm C's applicable internal governance, to release the change prior to validation and include the change in the next periodic Model re-validation. Firm C increases the ongoing performance monitoring in the interim period.	Consistent with GPS 8 ✔	The Model change is required to respond to market changes effectively and expeditiously. Firm C has conducted the appropriate reviews commissioned by senior management to ensure that the change does not result in a materially adverse impact or compromise the Mitigating Controls. Firm C's decision is informed by appropriate review and change controls including review of Residual Risk and involves the exercise of reasonable professional judgement pursuant to which it is determined that a retrospective Model Risk validation of the change is appropriate.