

**DECREE №151/04**

**Of the Governor of the National Bank of Georgia**

**August 17 2020**

**Tbilisi**

**On Approval of the Regulation about Data-driven Statistical, AI, and Machine Learning Model Risk Management**

Pursuant to Article 15, Paragraph 1, Subparagraph “g” of the Organic Law of Georgia on the National Bank of Georgia and Article 48, Paragraph 3 of the same Organic Law, I decree:

**Article 1.**

Approve the Regulation on Data-driven Statistical, AI, and Machine Learning Model Risk Management as attached.

**Article 2.**

This Decree shall enter into force on January 1, 2021.

**Article 3.**

1. From the day this decree enters into force, its application is extended to all models built or updated after this day.
2. The effect of this decree shall extend to all models from September 1, 2021.

Koba Gvenetadze

Governor of the National Bank of Georgia

## **Regulation on Data-driven Statistical, AI, and Machine Learning Model Risk Management**

### **Article 1. General Provisions**

1. The purpose of this Regulation is to promote the establishment of a risk management framework for statistical, artificial intelligence and machine learning models (hereinafter referred to as the Model) and to effectively manage the risks associated with it.
2. This Regulation defines the process of construction and use of models and its main components by the following entities under the supervision of the National Bank of Georgia - commercial banks, non-bank depository institutions, microfinance organizations, credit information bureau, and lending entities, which are legal entities (hereinafter referred to as legal entities).
3. This regulation applies to models, which may create material risk position if used by a legal entity.
4. The model user should have a model risk management system that is appropriate to the model user size, complexity of operations, organizational structure, business model, risk profile, and the potential impact of a particular model on the material risks of the model user.

### **Article 2. Definition of terms**

For the purposes of this Regulation, the terms used therein have the following meanings:

- a) Data-based statistical, artificial intelligence and machine learning model – a quantitative method or system that uses statistical, artificial intelligence or machine learning methods to transform input data into quantitative estimates and use them for financial, business and economic analysis in decision making;
- b) Supervisory model – a model that requires the risk assessment and approval of the model by the National Bank of Georgia and has been granted the status of a supervisory model by the National Bank of Georgia in accordance with the principles set forth in Article 10 of this Regulation;
- c) Internal validation – a set of internal actions and processes of the subject using the model, the purpose of which is to determine whether the behavior of the model is in line with expectations;
- d) Model risk – the risk of incurring losses (financial, reputational, strategic, etc.) as a result of incorrect formulation, implementation, use, calibration, coding and / or use of data;
- e) The principle of proportionality – taking into account the complexity of operations, organizational structure, business model, risk profile and model user to establish particular model's possible impact on the material risks of the entity using the model while establishing a model management system;
- f) Regulatory Laboratory – a regulatory laboratory defined by the Decree N110 / 04 of the Governor of the National Bank of Georgia of May 25, 2020 *On the Regulation on the Establishment of the Framework of the Regulatory Laboratory and its Use by the National Bank of Georgia*.
- g) Bias – an inclination or prejudice in the data and/or algorithm that systematically gives an unfair advantage to an individual or a group.

### **Article 3. Model risk management policies and procedures**

1. Risk management procedures related to the use of the models should be reflected in the internal policy-procedures of the entity using the model.

2. Internal policies-procedures should include a description of all model types, stages of model development, implementation and application, roles and responsibilities. Internal policies-procedures should pay special attention to model testing and analysis, internal validation, the need to determine the target accuracy of the model and the permissible level of error, procedures for reviewing and responding to unacceptable errors.
3. The internal policy-procedures should describe the requirements for the validation of the purchased model by internal and third parties.

#### **Article 4. Organizational Responsibilities Related to Model Risk Management**

1. Organizational responsibilities for model risk management, which include model development, internal validation and control, should be divided into three independent lines of defense:
  - a. First line of defense – a function responsible for the development, testing, use and risks associated with these processes;
  - b. Second line of defense – a function that should independently assess the process of developing, testing and using the model by the first line, the risks associated with these processes and at the same time should carry out internal validation. The second line of defense must notify the first line of problems or risks identified in the internal validation process and must have the power to restrict or prohibit the use of the model;
  - c. The third line of defense – the internal audit function, which should assess the effectiveness, completeness, accuracy and compliance of the model risk management process with this provision.
2. Given the principle of proportionality, the specific features and elements of the three lines of defense, as well as the degree of structural and qualitative separation, may differ, however, it must be ensured that the risks of the model are identified and critically assessed.
3. In the process of model management, the entity using the model should develop the principles of ethics, and the commercial bank should also be guided by the relevant principles defined by the *Code of Ethics and Professional Conduct Standards* approved by the Governor of the National Bank of Georgia (Decree №13/04 of February 2, 2021).

#### **Article 5. Model building and testing**

1. The first line of defense is responsible for building and testing the model.
2. The process of model building begins with the formation of the model goal. The structure, theory, and logic underlying the model should be documented, backed up by published research (if any), and consistent with industry practice. The model methodology and components, including the mathematical specification, should be explained in detail, which should include the strengths, assumptions, and limitations of the model. The components of the model must be proper both contextually and mathematical-statistically. For the reliability of the modeling process, existing assumptions and theories should be compared to alternative theories.
3. At the stage of model construction, the quality and relevance of the data used should be assessed and documented. The data and information should be appropriate for the model and should be consistent with the chosen methodology.

4. Data quality standards and policies should include the control of the following characteristics:
  - a. Completeness – data period, coverage should be adequate for the use of the model. Missing data should not have a material impact;
  - b. Accuracy – material errors, deviations, dropped data in the data must be excluded;
  - c. Compatibility – data obtained from different sources must match;
  - d. Timeliness – data should be updated periodically;
  - e. Uniqueness – duplication of data should be excluded;
  - f. Accessibility – data should be available to all three lines of defense involved in the process;
  - g. Audit trace – it should be possible to easily identify the operational processes carried out.
5. If the subject using the model is not convinced that the standards and policies related to data quality meet the requirements of paragraph 4 of this article, it should be the reason for restricting or suspending the use of the model.
6. The entity using the model should determine the statistical tests and metrics to be used in the data quality assessment process through internal policy-procedures. It should also reflect the approach used to the missing and dropped data. Internal policies-procedures should define methods for qualitative data evaluation in exceptional cases when statistical tests cannot be used.
7. The same standards and methods should be used to assess the relevance of data from different sources.
8. Proxy variables must be properly defined, specified and documented. If the data and information is not obtained from the model user or if the data and information is corrected, this process should be properly described and analyzed, so that the model user is aware of potential limitations. This should also be taken into account when receiving data / information from an external source.
9. In order to ensure the quality of the data, the entity using the model, in conjunction with paragraph 4 of this Article, should be guided by the basic principles of the Document on Effective Data Aggregation and Risk Reporting (BCBS239) of the Basel Committee on Banking Supervision.
10. An essential stage in model development is testing, which includes checking the accuracy of the model, assessing potential constraints, and evaluating the behavior of the model when changing the values of the input parameters. The test should evaluate the impact of the assumptions on the results and identify the circumstances under which the model's effectiveness decreases, meaning both a time period change and a sensitivity analysis. If necessary, testing should be carried out assuming different market conditions (baseline, optimistic, pessimistic) and should include all the products for which the model is designed. Various tests should be used to make the final conclusion. The testing procedure should be properly documented and should give a complete picture of the work performed.
- 10<sup>1</sup>. The model should be transparent and should allow for explanation and interpretation. In order to ensure transparency, the logic and technical content of the model and existence of the bias should be checked during the model validation process.
- 10<sup>2</sup>. For the complex models, where it is difficult to understand how input parameters are transformed into output as well as to identify causality between input parameters and output (“black box” models, including neural networks, ensemble methods, etc.) transparency should be achieved by employing following techniques:

- A. Global explanation techniques:
  - a) Partial Dependence Plot (PDP);
  - b) Variable Importance;
  - c) Surrogate Model (e.g. decision tree).
- B. Local explanation techniques:
  - a) Individual Conditional Expectation;
  - b) SHAP values;
  - c) Local interpretable model-agnostic explanations.

10<sup>3</sup>. The requirement regarding transparency increases if the decisions made by using the model have a direct impact on consumers and the decision-making process is highly automated.

11. After the launch of the model, the risk of the model should be monitored and relevant data should be provided to second line of defense.

#### **Article 6. Internal validation of the model**

1. The second line of defense is responsible for the internal validation of the model
2. In the process of internal validation, the consistency of the model's results with the objectives of its construction is checked. The internal validation process identifies potential constraints and assumptions and assesses potential impacts on the model. Staff doing internal validation should have the necessary knowledge, skills, expertise, and experience. The technical knowledge and qualifications of the staff should be commensurate with the complexity of the model.
3. The internal validation procedure should cover each of the following components of the model: inputs, calculations, and results. These requirements apply to models built by both the model user and third-party models
4. Internal validation should be conducted independently from model development and use.
- 4<sup>1</sup>. Internal validation should be conducted using a risk-based approach. The model user should create methodology of ranking/grouping models according to risk. The following materiality and the risk of deploying the model points should be taken into account:
  - A. In the process of determination materiality the following components should be considered:
    - a) Economic consequences of model error and / or misuse;
    - b) Possibility to influence the model user's important decision-making process;
    - c) Influence on the model user's financial and supervisory reporting;
  - B. In the process of determination risk of model deployment the following components should be considered:
    - a) Data accuracy and management;
    - b) Model design and complexity;
    - c) Documents related to the model;
    - d) Interdependence of models.

4<sup>2</sup>. Based on the model risk the model user should determine nature and intensity of internal validation.

5. The internal validation framework includes three main elements:

- a. **Evaluation of Conceptual Soundness**, which involves assessing the quality of model design and construction. It entails a review of documentation and empirical evidence supporting the methods used and variables selected for the model. Documentation and testing should convey an understanding of model limitations and assumptions. The general theoretical construction of the model, the basic assumptions, the data, and the mathematical calculations should be critically analyzed and checked:
  - i. Where appropriate to the particular model, banks should employ sensitivity analysis in model development and validation to check the impact of small changes in inputs and parameter values on model outputs to make sure they fall within an expected range. Unexpectedly large changes in outputs with regard to small changes in inputs can indicate an unstable model.
  - ii. Extreme values of the variables should be used to test the robustness of the model, to determine the boundaries of the model results, as well as the circumstances under which the model may become unstable. If testing has shown that the model is unstable, restrictions on the use of the model should be imposed and / or new approaches developed;
  - iii. The qualitative information, judgment, and logic employed in the development of the model should be evaluated to determine the conceptual accuracy of the model and the appropriate conditions for use. The internal validation process should ensure that the said procedure is carried out properly, is reasoned and documented
- b. **Ongoing monitoring**, which confirms that the model is appropriately implemented and is being used and is performing as intended. The purpose of ongoing monitoring is to assess the need to update the model after a change in product, customer, market position, or other important factors. The purpose of ongoing monitoring is to evaluate whether changes in products, clients, market conditions, or other important factors necessitate adjustment or redevelopment of the model. Any model limitations identified in the development stage and their impact on the model should be assessed as part of ongoing monitoring. This monitoring should be carried out periodically, with a frequency appropriate to the nature of the model, the availability of new data, and the magnitude of the risk involved. A program of ongoing testing and evaluation of model performance should be designed, which should include process verification and benchmarking:
  - i. Process verification checks that all model components are functioning as designed. It includes verifying that internal and external data inputs continue to be accurate, complete, and consistent with the model purpose and design, which means that the second line of defense must ensure the correctness of the data, request the data, check how logical it is and make sure the data conforms to the purpose of the model. At this stage, the correctness of the computer code and the change control mechanism are checked. The second line must run the model using the data and computer code used by the first line and compare the results to the results of the first line.
  - ii. Tests employed as part of model development should be reused when additional information becomes available. New empirical evidence or theoretical research may suggest the need to modify or even replace original methods.
  - ii<sup>1</sup>. If the results of the model validation are unsatisfactory and the use of new data and the new model is insufficient, the results and/or the parameters included in the model may be replaced based on expert judgment. The correctness of the implemented replacement should be justified by the analysis of quantitative results, including the analysis of the results on the past time period (back testing), and it should be constantly monitored.
  - iii. Ongoing monitoring should include the analysis of overrides made by expert judgment with appropriate documentation. The abundance of such overrides is an indication that, in some respect, the model is not performing as intended or has limitations.

- iv. When there is a discrepancy between the model results and the benchmark model, an additional analysis should be performed to determine the causes of the different outcomes;
  - v. Discrepancies between the model output and benchmarks should trigger an investigation into the sources and degree of the differences.
  - vi. Model risk should be reported regularly to senior management, in the case of a commercial bank to the supervisory board, and other lines of defense.
- c. **Outcome analysis**, that involves the comparison of model outputs to corresponding actual outcomes. Outcomes analysis typically relies on statistical tests or other quantitative measures and in some cases on expert analysis. The logical consistency of the results should be checked by the second line of defense. The evaluation criteria should be selected taking into account the methodology of the model, its complexity, data availability, and the scale of potential model risk for the model user. Back testing should be performed in parallel with updating the model. The objective of back testing is to determine the source of the error, that may stem from the omission of material factors from the model, from errors concerning other aspects of model specification (e.g. assumption of linearity), or be a purely random error. The choice of tests and the interpretation of results should be documented.
6. After the completion of the internal validation process, the second line of defense will draw the conclusion about the model risk. The second line of defense in the internal validation process uses the principle of proportionality depending on the importance and complexity of the model.

#### **Article 7. Audit**

1. The third line of defense (usually an internal audit) assesses the effectiveness of the model risk management framework. Internal audit should verify processes and documentation of model use and internal validation and ensure that internal validation is performed on time and models are subject to controls that appropriately account for any weaknesses in validation activities, and, generally, the model building and internal validation process complies with the requirements of this regulation.
2. The third line of defense should ensure that the model developing, updating, and internal validation processes are properly documented. Additionally, the third line of defense should perform assessments of supporting operating systems and evaluate the management of data used by models.
3. In the case of a commercial bank, the third line of defense must also meet the requirements of the code approved by the order of the President of the National Bank of Georgia No. 215/04 dated September 26, 2018, "On the approval of the corporate management code of commercial banks."

#### **Article 8. Model launch**

1. After a positive assessment of the model management process by all three lines of defense, a relevant technical qualified person/body, independent from defense lines, must approve the launch of the model. In the case of supervisory models, the top management of the entity decides to launch the model, while in case of a model that does not require the consent of the National Bank of Georgia, any qualified person, independent from the defense lines, not involved in the decision-making process, are eligible to approve model. If it is not feasible to conduct necessary validation activities prior to model use because of data paucity or other limitations, that fact should be documented and communicated in reports to the decision-maker and the model must be launched with appropriate restrictions.
2. In the case of a commercial bank, the members of the supervisory board must make sure that the model risk is following the commercial bank's risk appetite.

3. Regular reporting should be done to the person/body mentioned in paragraph 1 of this Article to assess the model risk. Significant changes in model risk and breaches of risk appetite should become a reason for restricting or suspending the use of the model.

#### **Article 9. Outsourcing**

1. The model user can outsource the model building, internal validation, and/or audit process. To avoid interfering with the supervisory process, outsourcing should be carried out in accordance with the outsourcing principles defined under article 8 of the *Regulation of the National Bank of Georgia on the management of operational risks at commercial banks* that is approved by the Decree №47/04 of the Governor of the National Bank of Georgia on 13 June 2014. The independence requirement of the three lines of defense must be met during the model building, internal validation, and audit processes.
2. In the case of outsourcing, model user is both owner and responsible person of the model. It should design a model development and documentation policy. The model user must be familiar with the technical side intuition and logic of the model and be able to interpret the model. These requirements apply to models developed by the parent company of the model user if the parent enterprise is not subject to the supervision of the National Bank of Georgia.
3. Outsourced products should be incorporated into a bank's broader model risk management framework following the same principles as applied to in-house models, although subjected to stricter standards.
4. To reduce model risk, the third party must provide the model user with a detailed description of the model development and internal validation processes. The third party should provide appropriate testing results that show their product works as expected. They should also clearly indicate the model's limitations, assumptions, and cases where the product's use may be problematic. Then, it must be determined whether the model is appropriate for the products of the model user. If third-party model development and validation documents are not available, the entity using the model must have its own data against which to test the model prior to purchase.
- 4<sup>1</sup>. The entity using the model should regularly receive the results of periodic model testing from a third party and verify the compliance of said results with its own risk appetite.
- 4<sup>2</sup>. If continuous monitoring of the purchased model is not performed by a third party in accordance with paragraph 4<sup>1</sup> of this Article, the model user should have the resources to verify that the model has been properly implemented, used and works as expected.
- 4<sup>3</sup>. The model user should use a risk-based approach to review the model supplied and purchased by a third party in order to ensure that the risk management of existing models is in line with expectations.
5. Model user should have contingency plans for such cases when the third party model is no longer available

#### **Article 9<sup>1</sup>. Principles of Ethics**

1. In the process of developing, implementing, and using the model, the model user must follow at least the following principles of ethics: unbiasedness and transparency.
2. The model design and model risk management process should be designed in such way that it does not create bias due to errors in the results, data, or algorithm.
3. Types of bias include the following:
  - a) **Sample bias** – This happens, when the data are not large enough or representative enough for modeling;



- b) **Stereotypical bias** – In this case, the data used to train the model reflects existing prejudices, stereotypes, and/or faulty societal assumptions that are not supported objectively;
  - c) **Behavioral deviation** – an irrational belief or behavior that can subconsciously influence the decision-making process. Behavioral biases are classified as either cognitive errors or emotional biases. Cognitive bias stems from the lack of qualifications and/or information, or incorrect processing of information. Cognitive bias can occur when the model user does not consider or modify new information that conflicts with previously held beliefs or cognitions. Emotional biases arise spontaneously and unconsciously because of attitudes and feelings that can cause the decision to deviate from rational decisions. The source of emotional deviation can be overconfidence, a tendency to maintain existing positions, a tendency to overestimate own assets, etc.;
  - d) **Exclusion bias** – Incorrect exclusion of important data from the data set (including considering important observation as an outlier).
4. To mitigate bias factors, the model user should:
    - a) Establish guidelines, rules, and procedures for identification, communication, and mitigation of data bias.
    - b) Monitor and, if possible, eliminate identifiable bias in during the data processing.
    - c) Check for the existence of bias in the model during the ongoing monitoring.
    - d) Controlling and elimination the use of outdated data, if the trend in the data is no longer relevant to the current situation.
    - e) Integrate all available relevant micro-level covariates into the model. The proxy variable should be excluded unless it is causally related to the dependent variable;
    - f) Prioritization to a socially neutral result if this does not significantly reduce the accuracy of the model;
    - g) In the modeling process, control the use of incorrect algorithms if the data contains some kind of bias.
  5. The model user should increase the transparency of the decision made by employing the model. In order to ensure transparency, the model user should, if necessary, be able to explain to the customer the logic of the model decision.
  6. The user of the model should contribute to the education and awareness of consumers about the decision made by using machine learning and artificial intelligence.

#### **Article 10. Requirements for Regulatory Model**

1. The model is identified as regulatory model by the National Bank of Georgia. In order to operate the regulatory model, it needs approval from the NBG. The decision about approval is based on the model risk assessment by the NBG. This validation is required for the following models:
  - a. Income estimation models, defined by Regulation of the Governor of NBG about Consumer Lending, Decree №44/04 dated 13 March 2020.
  - b. Models that are individually assigned as a regulatory model during the supervisory process of the legal entity considering the following principles:
    - i. Models that are or have a high potential to become a significant risk factor for the model user. These risks are associated with capital, financial loss, reputation, and other types of risks.
    - ii. New models in the market. An approach based on the principles of the Regulatory Laboratory may be applied to these models.

2. National Bank of Georgia identifies a model as regulatory model using the principle of proportionality and the risk-based approach.
3. When a model is assigned to regulatory model class individually, the National Bank of Georgia will determine the term (at least six months) for legal entity to comply with this regulation and apply to the National Bank of Georgia for the approval process.

#### **Article 11. Regulatory Model Approval Process**

1. The National Bank of Georgia approves only the regulatory models defined in the Article 10 of this Regulation. The National Bank of Georgia sets conditions and approves the use of regulatory model using risk-based approach and the principle of proportionality as defined in Article 2(e) of this Regulation.
2. In order to obtain approval for to use the regulatory model, the legal entity has to submit information about the model in a written form (preferably in the form of an article) to the National Bank of Georgia, which should include the following information:
  - a. Model owner;
  - b. The list of people who are responsible for the model;
  - c. Date of creation;
  - d. Motivation and purpose of the model;
  - e. The market segment, where the model will be used;
  - f. Data source and its detailed description;
  - g. The detailed description of the model development: which includes information about the model assumptions, the motivation behind the variable's selection, analysis of the impact of selected variables, and model assumptions on the outcome, model deficiencies.
  - h. The results of the internal validation;
  - i. Model evaluation criteria and test results that reflect the quality of the model, for example:
    - i. In the case of classification model: Accuracy, recall, precision, F1 score, ROC curve, Matthews correlation coefficient, Cohen's kappa, Confusion Entropy, etc.
    - ii. In the case of regression model: root mean square error (RMSE), mean absolute error (MAE), coefficient of determination, etc.
    - iii. Other relevant statistics and metrics for models.
  - j. Interpretation of results and its analyses;
  - k. Expert judgment and model outcome compatibility, if exists;
  - l. Result of benchmark model, if exists;
  - m. Sensitivity analyses, if exist.
3. After the legal entity submits all required information, The National Bank of Georgia will review the model within 30 working days. Based on the model risk evaluation result, NBG gives the conditional or unconditional approval or a substantiated refusal. In the case of complex models, this term may extend once. The complete term of model review after submitting the complete information should be no more than 90 working days.
4. In the case of conditional approval of the models, the National Bank of Georgia determines the conditions to use the model and the deadlines for submitting the relevant results. The National Bank of Georgia may use the Regulatory Laboratory approach, which means approving the use of the model for a limited period, subject to specific conditions and limits. If the model does not comply with the requirements set by the National Bank of Georgia, the NBG specifies a deadline to the legal entity to

improve the model and eliminate the deficiencies. After the deadline is passed, if the requirements are met, National Bank of Georgia will approve the model and reject otherwise.

5. The legal entity is obliged to develop and submit a monthly report to the National Bank of Georgia about the approved regulatory model, update the regulatory model at least annually, and submit an updated version to the NBG. The legal entity is also required to notify any significant meddling with the regulatory model, which results in a change of the regulatory model design, variables, or other parameters that affect the outcome of the model. The legal entity is obliged to justify the necessity for this change, and based on the error analyses, shows the advantage of the changed model. The National Bank of Georgia will review the submitted documentation within 30 working days, and in case of acceptable risk, give the right to make the change. Until the NBG gives the right to make the change in the regulatory model, the legal entity should continue to use the model with no above-mentioned changes.
6. When submitting the new regulatory model that replaces the old one, the legal entity is obliged to submit the results of the new and old regulatory models and justify the advantages of the new regulatory model.

#### **Article 12. Powers of the National Bank of Georgia**

For the purpose of model risk and model management process assessment, the National Bank of Georgia is authorized to take the following actions:

1. Request any information about the model from the legal entity; including the following:
  - a. Any result of the model (For example: in case of predictive regression model – prediction result);
  - b. Code required to run the model
  - c. Information that reflects the quality of the model/data
2. Conduct both remote and on-site inspections
3. Request to improve a model risk management framework in order to meet the requirements of this regulation;
4. Define model as a regulatory model;
5. Base on models' error analyses, request adjustments to model output;
6. Gives conditional or unconditional approval to use the regulatory model;
7. Imposes the limits for the use of the model and set the term for submission of model results in order to review the limits. The size and subsequent change of the limit will be affected by the results of the model monitoring and the improvement of the model risk management system, the risks that are identified in General Risk Assessment Program (GRAPE).
8. If the framework developed by the legal entity cannot provide an effective model risk management system, the NBG will require the legal entity to stop using the model until there will be an appropriate model risk framework system.
9. Consider the model and its management system within the General Risk Assessment Program (GRAPE) of the legal entity, including in Corporate Governance risk assessment.

#### **Article 13. The Supervisory Measures and Sanctions**

In case of violation of the requirements provided by this Regulation, the National Bank of Georgia is authorized to apply the supervisory measures and/or sanctions defined by the legislation of Georgia.