TERMS OF REFERENCE

Senior Economist / Macroeconomist – GEMMES-India Model Implementation, Data and Calibration

1. Background

The GEMMES India project, funded by Agence française de Développement and implemented by Expertise France aims to strengthen NITI Aayog's capacity to assess the macroeconomic and financial implications of India's long-term development and energy-transition pathways. GEMMES-India is intended to complement NITI Aayog's existing suite of energy and climate modelling tools by enabling analysis of the interactions between economic growth, investment, employment, public and private finance, external balances, energy transition and other macroeconomic variables.

The NITI Aayog–AFD framework envisages GEMMES-India as an open-economy, stock-flow consistent macroeconomic model capable of examining interactions between capital accumulation, public and private debt, under-employment, financial conditions, natural-resource constraints and distributional considerations. It also envisages linkages with detailed energy-system models such as TIMES. NITI Aayog already has detailed energy-system modelling capabilities, including the India Energy Security Scenarios (IESS) and TIMES models, whose scenario outputs will be available as inputs to GEMMES-India and need not be redeveloped under this assignment.

The expert will be mobilized by Expertise France to work on GEMMES-India over a period of 24 months. The expert's contribution centers on the macroeconomic modelling work: the construction of the model's database, the implementation and calibration of the model, and the computational tools and documentation that make it operational and reproducible. The expert will also take part in the technical exchange with NITI Aayog, in capacity building and in the policy dialogue around the model's results.

2. Objective of the Assignment

The overall objective of the assignment is to contribute to the development, calibration and documentation of an operational GEMMES-India model and its supporting database, so that NITI Aayog and AFD Group can assess the macroeconomic and financial implications of India's development and energy-transition pathways and NITI Aayog can run and update the model independently.

The specific tasks related to the assignment are :

- lead the construction of a coherent, reproducible macroeconomic, financial and sectoral database for GEMMES-India from Indian national accounts, flow-of-funds, input-output, balance-of-payments, labour, price and financial statistics;
- contribute to the specification of the GEMMES-India model and implement it in code with the AFD GEMMES team, including its accounting framework, behavioural equations, closures and initial conditions;
- estimate and calibrate the model on historical Indian data with the AFD GEMMES team, validate it through historical simulation, back-testing and sensitivity analysis, and document the calibration;
- implement the GEMMES side of the interface through which agreed TIMES/IESS scenario outputs enter the model;
- implement and run the agreed development, energy-transition and financing scenarios, produce the quantitative results on which the programme's technical reports and policy findings are based, and contribute to their interpretation;
- provide the computational environment, code organisation and technical documentation that allow NITI Aayog staff to run, update and extend the model after the assignment;

- work with NITI Aayog and AFD Group colleagues on the coordination of the modelling work, capacity building and the policy dialogue around the model's results.

3. Scope of Work

The expert will work under the direction of the AFD project lead for GEMMES-India, as part of the AFD GEMMES team and in collaboration with NITI Aayog. The scope is organised in the same five areas as the overall GEMMES-India work programme, with a sixth covering coordination, capacity building and policy dialogue. The work in each area is shared within the GEMMES-India team; the paragraphs below indicate where the expert's contribution is expected to be concentrated.

3.1 GEMMES-India model architecture and implementation

The specification of the GEMMES-India model (institutional and sectoral structure, behavioural assumptions, India-specific transmission channels) is developed by the AFD GEMMES team with the expert's participation as a macroeconomist experienced in stock-flow consistent models. The expert will take a leading part in implementing that specification in code. This includes:

- implementing the model's accounting framework (transaction-flow matrix, balance sheets and revaluation accounts) in code, and verifying its stock-flow consistency numerically;
- implementing the behavioural equations, closures and policy rules agreed with the AFD GEMMES team, and translating subsequent revisions into the code base;
- developing the numerical routines required to solve, initialise and diagnose the model, including the computation of initial conditions consistent with the database;
- helping to organise the model code base and its computational environment so that the model is reproducible and can be run by NITI Aayog staff from documented instructions;
- documenting the implemented equations, variables, parameters and modelling choices, and contributing the corresponding sections of the technical notes and reports;
- reviewing behavioural assumptions and equations against Indian data and empirical evidence, and proposing alternative specifications to the AFD GEMMES team where the data warrant them.

3.2 Development of the GEMMES-India database

The expert will lead, with the AFD GEMMES team and the NITI Aayog support team, the construction of the GEMMES-India database. The database is expected to draw on National Accounts and institutional sector accounts; Supply and Use Tables, Input-Output Tables and Social Accounting Matrix information; Flow of Funds and financial accounts; Balance of Payments, capital flows and trade data; employment, labour-force and wage statistics; prices and sectoral deflators; interest rates and financial-sector indicators; sectoral production and investment; and relevant energy and emissions variables. The work includes:

- mapping GEMMES variables to authoritative Indian data sources and identifying the data-owning institutions, in coordination with NITI Aayog, which facilitates access to and interpretation of Indian datasets;
- building a reproducible data-processing pipeline from raw source files to the consolidated GEMMES-India dataset, so that the database can be rebuilt and updated from documented inputs;
- reconciling variables drawn from different statistical systems, including the real and financial perspectives on sectoral net lending, and identifying and treating gaps, discontinuities and statistical discrepancies;
- constructing the derived variables, historical time series and integrated transaction-flow and balance-sheet matrices required by the model;
- integrating input-output and sectoral production information consistent with the model's sectoral structure;
- preparing metadata, source documentation and a data dictionary;

- providing technical guidance to the NITI Aayog support team on the data pipeline so that it can be maintained and updated after the assignment.

3.3 Calibration and validation of GEMMES-India

The expert will take a leading part in the calibration and validation of the model, in collaboration with the AFD GEMMES team. Key tasks include:

- estimating model parameters from the historical database using appropriate econometric, Bayesian or moment-based methods, and calibrating parameters that cannot be estimated;
- computing initial conditions and the baseline/reference trajectory consistent with the database;
- conducting historical simulations and back-testing of key macroeconomic relationships;
- examining model stability and sensitivity to major parameters and assumptions;
- documenting calibration assumptions, estimation methods, parameter values and diagnostics;
- identifying where the data or diagnostics indicate that alternative specifications are required, and proposing them to the AFD GEMMES team;
- incorporating agreed revisions following technical review by NITI Aayog and AFD, and supporting consultations with sectoral and macroeconomic experts on calibration questions.

The outcome should be a calibrated core GEMMES-India model that reproduces key historical macroeconomic relationships and serves as the basis for forward-looking policy scenarios.

3.4 Integration of existing TIMES/IESS scenarios

NITI Aayog will provide agreed outputs from its existing TIMES and IESS modelling exercises. NITI Aayog's energy modelling team and the programme's energy and climate modelling lead are responsible for the provision and interpretation of these outputs. The expert contributes to the integration work by:

- specifying the variables, units, frequency and format in which TIMES/IESS outputs are required by GEMMES-India;
- implementing the GEMMES side of the TIMES/IESS-to-GEMMES interface, i.e. the reproducible routines that read the agreed outputs and translate them into the model's capital formation, sectoral investment, production, import, expenditure, energy-price, financing, employment and productivity channels;
- implementing in the model the bridging assumptions agreed between the AFD GEMMES team and NITI Aayog on domestic versus imported equipment, public versus private investment, financing structure, depreciation and asset life, gestation periods and the allocation of investment across sectors and institutional agents;
- implementing, where relevant, adaptation-related inputs supplied by NITI Aayog's separate adaptation workstream as additional investment or expenditure assumptions. The expert does not undertake adaptation-costing work.

3.5 Scenario and policy analysis

The set of policy-relevant scenarios is agreed jointly by NITI Aayog and AFD. The expert contributes to their implementation, analysis and interpretation by:

- implementing in the model the scenario machinery required to combine baseline/development pathways, TIMES/IESS energy-transition pathways, alternative investment requirements and financing strategies, including domestic private and public finance, commercial and concessional borrowing, grants and climate transfers, green bonds and other debt instruments, and alternative cost-of-capital assumptions;
- running the agreed scenarios and producing the quantitative results for GDP and sectoral output, investment, household consumption, employment and wages, inflation, public revenue and expenditure, fiscal deficit, public and private debt, trade and current-account balances, capital

flows, energy imports, energy-transition investment and emissions, with particular attention to the banking system and monetary-policy dimensions;

- conducting sensitivity and stress testing of major assumptions;
- preparing the results tables, charts and technical sections (data, model, calibration, simulation methods) of the technical reports, contributing to the interpretation of results and to policy notes and presentations, and participating in stakeholder and technical consultations on the results.

3.6 Coordination, capacity building and policy dialogue

Alongside the technical work, the expert will take part in the collaborative and institutional side of the programme. This includes:

- working with AFD Group and NITI Aayog colleagues to plan and sequence the data, modelling and integration work, and to identify where inputs from other teams or institutions are needed;
- engaging with NITI Aayog, DEA, MoEFCC, RBI and other relevant teams on data, modelling assumptions and results;
- contributing to the capacity-building activities described in Section 6;
- participating in the technical workshops, consultations and policy dialogue through which the model's results are discussed with NITI Aayog and other stakeholders.

4. Deliverables and Timeline

The assignment follows the deliverable schedule of the overall GEMMES-India work programme, reproduced below. The expert's contribution to each deliverable is as set out in Section 3; the allocation of the expert's outputs to these milestones is to be finalised.

Timeline	Deliverable	Key Outputs
Month 3	**D1: GEMMES Technical Familiarisation, Model Architecture and India Data Mapping**	• Technical training and familiarisation on GEMMES architecture, equations and modelling approach. • Review of the existing GEMMES structure and identification of India-specific modelling requirements. • Preliminary definition of institutional and sectoral structure for GEMMES-India. • Detailed mapping of GEMMES variables to Indian datasets and relevant data-owning institutions. • Mapping of available TIMES/IESS outputs relevant for GEMMES integration. • Identification of critical data gaps and data-quality issues. • Detailed work plan for subsequent model and database development.
Month 6	**D2: First Draft of GEMMES-India Dataset**	• First consolidated GEMMES-India dataset covering key macroeconomic, fiscal, financial, external-sector, labour and sectoral variables. • Documentation of data sources and definitions. • Preliminary reconciliation of variables across different datasets. • Identification of remaining data gaps, inconsistencies and statistical discrepancies. • Initial mapping of Input-Output, Supply-Use Table and SAM datasets.

Timeline	Deliverable	Key Outputs
		• Preparation of metadata and data dictionary. • Plan for subsequent data refinement, harmonisation and automation.
Month 12	**D3: Core GEMMES-India Prototype**	• First operational GEMMES-India model prototype. • Development of the core accounting framework. • Implementation of principal behavioural equations. • Preliminary model calibration. • Historical simulation of key macroeconomic variables. • Initial diagnostic assessment of model performance. • Technical note documenting model structure, equations, assumptions and outstanding data/model gaps.
Month 15	**D4: Calibrated GEMMES-India Core Model**	• Revised and reconciled GEMMES-India database. • Calibrated macroeconomic and financial model. • Historical back-testing of key model relationships. • Sensitivity analysis of major model parameters. • Development of baseline/reference economic trajectory. • Technical review with NITI Aayog and AFD. • Incorporation of revisions arising from technical review.
Month 18	**D5: Energy-Transition Integration**	• Mapping of energy-transition investments into relevant macroeconomic channels. • Integration of energy imports, energy costs and other relevant energy-system variables. • Development of required bridging assumptions between energy-system and macroeconomic models. • First demonstration simulations using agreed TIMES/IESS scenarios.
Month 21	**D6: Integrated GEMMES-India Model – Beta Version**	• Integrated macroeconomic and energy-transition model. • Reproducible TIMES/IESS-to-GEMMES interface. • Representation of alternative public, private and external financing mechanisms. • Incorporation, where relevant, of adaptation-related inputs generated through NITI Aayog's parallel adaptation work. • Integrated scenario simulations. • Interim technical documentation of the integrated model.
Month 2	**D7: Policy Scenario Assessment**	• Finalisation of agreed development, energy-transition and financing scenarios. • Comparative assessment of macroeconomic outcomes across scenarios. • Analysis of fiscal, employment, debt and external-sector impacts. • Sensitivity and stress testing of major assumptions. • Preparation of draft technical report.

Timeline	Deliverable	Key Outputs
		• Preparation of draft policy findings. • Stakeholder and technical consultation on results.
Month 24	**D8: Final GEMMES-India Model and Handover**	• Final calibrated and validated GEMMES-India model. • Final GEMMES-India database. • Final TIMES/IESS integration interface. • Technical documentation of model architecture, assumptions and calibration. • Final technical report and policy brief. • Training and knowledge-transfer sessions. • Final technical seminar/workshop.

5. Working Arrangements and Responsibilities

The expert will report to the AFD project lead for GEMMES-India and work as part of the AFD GEMMES team and Expertise France project team. in close collaboration with NITI Aayog's GEMMES-India team. The expert will work remotely, with missions to New Delhi and possibly Paris.

The expert will:

- contribute substantially to implementing, maintaining and documenting the GEMMES-India model code, data pipeline and calibration routines, and act as a point of reference for technical and software questions concerning them;
- help set up and document the computational environment (software, packages, version control and execution instructions) used by the programme, so that NITI Aayog's working copies can be installed and run from that documentation;
- work directly with the AFD GEMMES team on model specification, estimation and the interpretation of diagnostics;
- work with NITI Aayog teams on the identification and acquisition of Indian datasets, the specification of the TIMES/IESS interface and the scheduling of technical work, and engage with NITI Aayog, DEA, MoEFCC, RBI and other Indian institutions as needed;
- provide technical guidance to the NITI Aayog support team on the data pipeline, model code and calibration routines;
- participate in regular technical meetings, technical workshops and reviews, and in the policy dialogue around the model's results;
- contribute to technical notes, reports, policy notes and presentations, and support the dissemination of results through agreed NITI Aayog/AFD platforms, including ICEMF where relevant.

NITI Aayog will facilitate access to and interpretation of Indian datasets and TIMES/IESS outputs and coordination with its teams. Where an input required for the expert's work is provided late, the corresponding dates in Section 4 are adjusted accordingly by agreement.

6. Capacity Building and Knowledge Transfer

A key objective of the programme is to institutionalise GEMMES modelling capability within NITI Aayog. The expert will participate in continuous knowledge transfer throughout the assignment, with a particular focus on the parts of the system the expert helps to build. This includes:

- documented, reproducible code for the database, model and calibration, written so that it can be read and modified by economists who did not build it;
- technical sessions for the NITI Aayog support team on rebuilding and updating the database, running and modifying the model, estimating parameters, integrating TIMES/IESS outputs and running scenarios;
- participation in the broader training, workshop and policy-dialogue activities of the programme, including the interpretation of model results for a policy audience;
- contributions to the training and knowledge-transfer sessions and the final technical seminar foreseen under Deliverable D8;
- a handover of the model, database and documentation at the end of the assignment, in a form that NITI Aayog staff can operate independently.

The number and format of technical sessions will be agreed in the work plan under Deliverable D1.

7. Minimum Qualifications and Professional Experience

Minimum Educational Qualification

A PhD in Economics, with a specialisation in macroeconomics, macroeconometrics or computational economics, from a reputed national or international institution.

Professional Experience

- at least eight years of professional experience in macroeconomic modelling, of which a substantial part in the construction and calibration of structural macroeconomic models for policy institutions;
- demonstrated experience in building stock-flow consistent macroeconomic models, including the construction of transaction-flow and balance-sheet matrices and the treatment of financial stocks and flows;
- extensive experience with macroeconomic data and the system of national accounts: institutional sector accounts, Supply and Use and Input-Output tables, Flow of Funds, Balance of Payments and labour and price statistics, including the reconciliation of data from different statistical systems;
- strong skills in numerical methods for dynamic economic models: solution of systems of differential or difference equations, computation of steady states and initial conditions, estimation by Bayesian, likelihood or simulated-method-of-moments techniques, and sensitivity analysis;
- proven programming experience in a scientific computing language (Julia, Python or R), including the design of reproducible data pipelines, version control and the organisation of model code for use by others;
- experience in working with government institutions, central banks or development partners on applied modelling projects, in particular scenario analysis of climate change and the energy transition, including the documentation and handover of models;
- strong analytical and written communication skills in English.

Experience with the GEMMES modelling framework, with energy-system models such as TIMES or LEAP and their coupling to macroeconomic models, and with climate-finance analysis would be an advantage.

8. NITI Aayog Support Team

A dedicated NITI Aayog team of four members (two energy modelling specialists and two climate finance specialists) supports implementation of GEMMES-India. The expert will work with this team on the data pipeline, model code and calibration routines, and will help review and integrate the data and financing inputs it produces into the database and model. Task allocation across the support team is coordinated by NITI Aayog.

9. Technical and Financial Proposal

Candidates shall submit:

- a detailed CV highlighting relevant experience and availability;
- a concise technical proposal, of no more than two pages, presenting their understanding of the assignment and proposed methodology;
- references for comparable assignments; and
- a financial proposal indicating the proposed daily fee inclusive of all applicable taxes.

10. Other relevant information

The assignment may require participation in technical workshops, consultations and missions in India and, where agreed by NITI Aayog and AFD, international technical meetings or missions.

This part-time position consists in a maximum number of 240 men/days over 24 months. Beginning of activities is expected in November 2026.