The Coalition of Finance Ministers for Climate Action

MFMod-CC: country-specific macrostructural models

World Bank

Andrew Burns, Charl Jooste, Florent McIssac, Chung Gu Chee, Heather Ruberl, Thi Thanh Bui, Unnada Chewpreecha, Alex Haider, and Baris Tercioglu

A contribution to the 'Compendium of Practice from a Global Community of Ministries of Finance and Leading Organizations: Economic analysis and modeling tools to assist Ministries of Finance in driving green and resilient transitions'

Topic: Modeling tools relevant to Ministries of Finance

June 2025

Access the full Compendium at www.greenandresilienteconomics.org

This contribution was prepared at the request of, and with guidance from, the Ministry of Finance of Denmark as Lead of the Coalition's Helsinki Principle 4 initiative 'Economic Analysis for Green and Resilient Transitions' and its Steering Group, with input from its Technical Advisory Group. The views, findings, interpretations, and conclusions expressed are those of the authors. While many Coalition members and partners may support the general thrust of the arguments, findings, and recommendations made in this contribution, it does not necessarily reflect the views of the Coalition, its members, or the affiliations of the authors, nor does it represent an endorsement of any of the views expressed herein by any individual member of the Coalition.

Overview

MFMod CC is a family of semi-structural macroeconomic models developed by the World Bank (Burns et al., 2019; Burns and Jooste, 2019). Like a dynamic stochastic general equilibrium (DSGE) model, MFMod is neoclassical in nature, with firms and households maximizing utility and profits subject to budget and resource constraints. These types of models are more flexible than DSGE models and are traditionally used by central banks and MoFs[1] as the main forecasting and policy models.

A typical model consists of over 300 variables covering the national income expenditure and production accounts, government fiscal accounts, the current and financial accounts of the balance of payments, and labor market data. The climate change versions model climate mitigation, damages, and adaptation (Burns et al., 2021a,b; Hallegatte et al., 2024a), and the transition effects of moving toward a renewable energy economy (Hallegatte et al., 2024b; Chewpreecha et al., 2024).

Model parameters are estimated on country-specific data, with the behavioral equations of the models comprising a long-run equation (consisting of a theoretically derived long run based on neoclassical optimization behavior) and a predominantly data driven short-run component, while also allowing frictions. Long-run supply is anchored by the supply of labor, the capital stock, and Total Factor Productivity (TFP), all of which can be endogenized to greater or lesser extents (including the role of innovation, competition, or education). In contrast, DSGE models typically derive this steady state using calibrated parameters, particularly in data-limited contexts such as developing economies.

MFMod-CC has been soft-linked to several models (including household distribution models, microprudential frameworks, energy systems, and biophysical models). MFMod produces findings on the implications of climate change and climate policy on variables such as GDP, household consumption, inflation, interest rates, unemployment rates, CO_2 emissions, the energy mix, sovereign debt, fiscal balances, and value-added by sector and trade (both current and financial and capital accounts).

Strengths and limitations

The key strengths of MFMod include:

- Country-specific parameter estimates and behavior
- Transition dynamics to long-term equilibrium that are consistent with economic behavior, structural transformation, and local circumstances
- Incorporation of supply-side constraints through the production function, which imposes limits on benefits from policy responses, unlike demand-only models
- Explicit incorporation of household- and firm-optimizing behavior, which generates the kind of endogenous adaptation that reduces negative impacts even in the absence of Government action
- Both demand and supply react endogenously to changes in technology, prices, and resources.

The framework has the following limitations:

- Because detailed sectoral information is not often available as time-series data, the model tends to have less sectoral detail than CGE- or IO-based models, which extrapolate data taken from a single point in time.
- Input-output tables can be used to generate a finer disaggregation. In this configuration higher-level aggregates are determined by the model, and finer levels disaggregation can be generated either by using fixed coefficients—similar to an IO model–or by taking a more flexible CES-style production approach as in CGE models.

1 For the US Fed see Brayton et al. (2014), for the Bank of France see Lemoine et al. (2019), for the ECB see Angelini et al. (2014), and for the Australian central bank see Ballantyne et al. (2019).

- Disaggregation of results to the subnational level is not possible for most countries because subnational time-series data are available for only a few countries. Coupling model results with household surveys or biophysical models allows these limitations to be overcome.

Relevance to Ministries of Finance

Key benefits of MFMod include:

- Its embedding into core day-to-day Ministry economic analysis, climate outcomes, and climate policies alongside other policy priorities
- Comprehensive fiscal accounts ensure the economy-wide impacts of spending and tax policies and large-scale spending programs such as energy transitions are accounted for
- Compared with other general equilibrium models, MFMod is relatively easy to work with, and as a result, staff can be staff trained and retained relatively quickly, and policy analyses run on the fly as questions arise
- Ease of use also facilitates stochastic simulations and the interaction of non-climate and normal economic scenarios such as a financial crisis (Giuliano et al., 2024).

Key policy/analytical questions addressed:

- What are the economic, fiscal, and monetary policy implications of the energy transition?
- What are the economic, fiscal, and monetary policy implications of climate policy?
- How do climate policies stack up against other policy priorities (investment in education, infrastructure or labor markets)?
- What are the implications of climate change and policies for people, jobs, wages, and consumer prices?
- Can subsidies to households mitigate the impact on the poorest without excessively impacting growth?
- How do physical and fiscal constraints interact with climate policy sensitive are prices to climate change and how are households affected?

Use in practice

MFMod is built on and includes standard macroeconomic accounts. It has an easy-to-use Excel interface that allows nonspecialist analysts to construct baseline forecasts and scenarios without learning any programming. The model code is transparent and can be modified and adjusted by specialized Ministry staff that wish to delve deeper. Models are available in Eviews and Python.

As the model covers almost all of the macroeconomic areas of concern for an MoF (forecasting, fiscal sustainability, inflation, balance of payments), it can be used for standard macroeconomic policy analysis as well as climate analysis, and can also be used to evaluate the climate impacts of policies that do not focus on climate per se. MoFs in more than 40 developing countries have been trained on the MFMod system, and it is being used in many as a regular part of their analytical, budgetary, and forecasting exercises. The climate version is newer. Staff at about 15 MoFs have been or are being trained on the system.

Lessons and challenges

Models such as MFMod are familiar tools for MoF staff. Such models are among the main types of tools used by MoFs and central banks the world over for forecasting, budgetary planning, and policy analysis. Embedding climate features into an otherwise standard macro-model reduces the learning curve for staff. The World Bank has an active program building these models for MoF clients and training them on their use and maintenance.

Future work

No model is ever complete. MFMod is built by several people and will continue to develop. As more data becomes available, so too will the richness of the model. Current work entails endogenizing more

features of total factor productivity, via endogenous changes to land demand and supply, adding Schumpeterian assumptions for growth, and enriching the financial sector.

Analysis in action

The macro analysis of climate change in about two-thirds of all World Bank CCDRs was conducted using MFMod. These include several climate policies and climate change assumptions. These are all documented at: www.worldbank.org/en/publication/country-climate-development-reports.

Conclusions

MFMod is a flexible yet robust model that can be easily deployed by MoFs for analyzing both macroeconomic policies and the climate's effect on the macroeconomy. The model is used for both macro projections and simulation. The international community is encouraged to use and help improve MFMod, by integrating key features that improve the precision of the model.

References

Angelini, Elena, Nikola Bokan, Kai Christoffel, Matteo Ciccarelli and Srečko Zimic (2019) *Introducing ECB-BASE: The Blueprint of the New ECB Semi-Structural Model for the Euro Area*. ECB Working Paper 2315. https://data.europa.eu/doi/10.2866/46942

Ballantyne, Alexander, Tom Cusbert, Richard Evans, Rochelle Guttmann, Jonathan Hambur, Adam Hamilton, Elizabeth Kendall, Rachael McCririck, Gabriela Nodari and Daniel M. Rees (2020) MARTIN Has Its Place: A Macroeconometric Model of the Australian Economy. *Economic Record* 96(314), 225–251. https://www.rba.gov.au/publications/rdp/2019/2019-07.html

Brayton, Flint, Thomas Laubach, and David Reifschneider (2014) *The FRB/US Model: A Tool for Macroeconomic Policy Analysis.* FEDS Notes, April 03. Washington: Board of Governors of the Federal Reserve System. https://doi.org/10.17016/2380-7172.0012

Burns, Andrew, and Charl Jooste (2019) *Estimating and Calibrating MFMod: A Panel Data Approach to Identifying the Parameters of Data Poor Countries in the World Bank's Structural Macro Model*. Policy Research Working Paper WPS 8939. Washington, D.C.: World Bank Group. http://documents.worldbank.org/curated/en/662391562848917501

Burns, Andrew, Benoit Campagne, Charl Jooste, David Stephan and Thi Thanh Bui (2019) *The World Bank Macro-Fiscal Model Technical Description*. Policy Research Working Paper 8965. Washington, D.C.: World Bank Group. http://hdl.handle.net/10986/32217

Burns, Andrew, Charl Jooste and Gregor Schwerhoff (2021a) *Climate Modeling for Macroeconomic Policy A Case Study for Pakistan*. Washington, D.C: World Bank. https://doi.org/10.1596/1813-9450-9780

Burns, Andrew, Charl Jooste and Gregor Schwerhoff (2021b). *Macroeconomic Modeling of Managing Hurricane Damage in the Caribbean the Case of Jamaica*. Policy Research Working Paper 9505. Washington, D.C: World Bank. http://hdl.handle.net/10986/34982

Chewpreecha, Unnada, Francis Dennig and Ib Hansen (2024) *FTT-FLEX: Flexible Technology Diffusion Analysis Tool for Data Poor Countries*. Policy Research Working Paper WPS 10767. Washington, D.C.: World Bank Group. http://documents.worldbank.org/curated/en/099735005082423970

Giuliano, Fernando, Daniel Navia and Heather Ruberl (2024) *The Macroeconomic Impact of Climate Shocks in Uruguay.* Policy Research Working Paper WPS 10740. Washington, D.C.: World Bank Group. http://documents.worldbank.org/curated/en/099400003272435890

Hallegatte, Stéphane, Charl Jooste and Florent McIsaac (2024) Modeling the Macroeconomic Consequences of Natural Disasters: Capital Stock, Recovery Dynamics, and Monetary Policy. *Economic Modelling* 139, Paper 106787. https://doi.org/10.1016/j.econmod.2024.106787

Hallegatte, Stéphane, Florent Mc Isaac, Hasan Dudu, Charl Jooste, Camilla Knudsen and Hans Beck (2024b) *Macroeconomic Implications of a Transition to Net Zero Emissions Approaches of and Lessons from World Bank Group Country Climate and Development Reports, with an Application to*

Turkey. Washington, D.C.: Peterson Institute for International Economics. https://www.piie.com/sites/default/files/2024-03/wp24-6.pdf

Lemoine, Matthieu, Harri Turunen, Mohammed Chahad, Antoine Lepetit, Anastasia Zhutova, Pierre Aldama, Pierrick Clerc and Jean-Pierre Laffargue (2018) *The FR-BDF Model and an Assessment of Monetary Policy Transmission in France*. Banque de France. https://publications.banque-france.fr/sites/default/files/medias/documents/wp736.pdf