The Coalition of Finance Ministers for Climate Action

DIGNAD: Debt-Investment-Growth and Natural Disaster model

International Monetary Fund (IMF) Research Department

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

The DIGNAD (Debt-Investment-Growth and Natural Disaster) model and toolkit were developed in the IMF's Research Department, building on the Debt, Investment and Growth (DIG) model of Buffie et al. (2012) and its extension to natural disasters by Marto et al. (2018). The model was developed to analyze the macro-fiscal impacts of natural disasters and investments in resilience in lower-income countries. With its dynamic general equilibrium (DGE) structure, the model captures the effects of public investment on growth and debt sustainability in developing countries that frequently face natural disasters. The model can also be used to analyze the effects of ex-ante policies, such as building adaptation infrastructure, increasing fiscal buffers, or improving public investment efficiency.

The DIGNAD toolkit, launched externally in 2023, features a user-friendly Excel interface.

DIGNAD has become a workhorse model in the IMF to study the effects of climate risk due to natural disasters and the potential for investments in climate-resilient infrastructure to mitigate these risks. It has been applied to dozens of countries, with the analyses featured both in the IMF's Article IV staff reports and in countries' request for financing from the Resilience and Sustainability Trust (RST).

The DIGNAD toolkit and user manual are hosted at the IMF Climate Change Dashboard: https://climatedata.imf.org/pages/dignad. It can be also reached at www.imf.org/DIGNAD.

Strengths and limitations

The DIGNAD toolkit provides a user-friendly interface that is entirely based on Excel, meaning users are not constrained by the need for familiarity with Matlab or Dynare. With all inputs provided in an Excel spreadsheet, the user can calibrate the model to define disaster and financing scenarios and shocks. The model's output is saved in charts, as well as in a separate Excel file. Various scenarios can be compared through the use of a graphic tool. However, even though users can run and modify the model entirely from Excel, Matlab does need to be installed on the user's computer, which could pose a limitation currently. An ongoing collaboration with MathWorks aims to create an online application that would enable users to access DIGNAD through any web browser, without downloading and installing Matlab.

Relevance to Ministries of Finance

DIGNAD is suitable for studying the macro-fiscal implications of investment and natural disasters, and thus should be of great relevance to MoFs, especially in countries prone to natural disasters. It can be easily tailored to country-specific scenarios, macroeconomic context, and country-relevant policy considerations. The model is very user-friendly and publicly available, and it can be easily understood and run by economists in a short timeframe. The Excel output, automatically produced with any simulation, provides a quick overview of up to 16 economic variables. These charts can be used to easily view and communicate the model's results.

Key questions addressed

The model can address various policy and analytical questions, such as:

- What is the impact of natural disasters on key macroeconomic variables such as GDP and fiscal deficit?
- What is the impact on debt sustainability, and how does the impact vary with the mode of financing (e.g., grants or loans, concessional or market-based, etc.)?
- What are the relative benefits and costs of investing ex-ante in climate-resilient infrastructure versus rebuilding the capital stock destroyed by the natural disaster ex-post?
- Are there complementary policies that can help mitigate the trade-offs faced by the government (e.g. increasing the efficiency of public spending)?

The model is designed to evaluate the impact of a one-off natural disaster, where the size of the impact is calibrated using historical data on economic losses. In the model, natural disasters affect the economy via four channels: damages to public and/or private capital, temporary productivity loss,

decline in public investment efficiency, and/or loss in creditworthiness. The relevance of these channels is calibrated by the user. Public capital, affected by the disaster, can be rebuilt by the government, but this entails fiscal costs. Private capital is rebuilt through endogenous private sector investments. The other two channels—reduced efficiency of government investment in infrastructure and an increase in the risk premium due to a perceived reduction of creditworthiness—can also be reflected in the model (or be switched off entirely), and their magnitude is specified by the user.

The model includes two types of public infrastructure: standard and climate-resilient infrastructure. Resilient infrastructure has three distinct benefits: it is more durable (that is, it has a lower depreciation rate), suffers smaller damages from natural disasters, and has a higher rate of return. However, it is often more expensive than standard infrastructure. The model can also consider the value of building fiscal buffers in an external natural disaster contingency fund to finance post-disaster reconstruction. The upside is that this ensures financing if access to (external) finance becomes curtailed or prohibitively expensive when needed most. The downside is that saving in a contingency fund might divert resources from investing in climate-resilient infrastructure.

Use in practice

The DIGNAD model has become a workhorse model in the IMF to study the effects of climate risk due to natural disasters and how investments in adaptation infrastructure can help mitigate these risks. Since 2017 there have been over a dozen applications of the DIGNAD model in Article IV staff reports and Selected Issues papers, as well as in flagship publications such as the External Stability Report (ESR) and working papers. Some examples include:

- IMF Working Papers: Vanuatu (2017), St Lucia (2019), Maldives (2021)
- Selected Issues: Solomon Islands (2018), Uganda (2022), Timor-Leste (2022), Philippines (2023), Rwanda (2023)
- Pilot Climate Macroeconomic Assessment Programs (CMAPS): Samoa (2022) and Madagascar (2023)
- Resilience and Sustainability Trust (RST) pilots: Rwanda (2022) and Bangladesh (2023)
- RST: Seychelles (2023), Kenya (2023), Benin (2023), Mauritania (2023), Moldova (2023), Cameroon (2023), Cote d'Ivoire (2024), Tanzania (2024), Democratic Republic of the Congo (2025)

IMF's Research Department in collaboration with the Institute of Capacity Development (ICD) delivers training, workshops, and webinars to IMF economists and external participants on DIGNAD.

Future work

The DIGNAD team is currently working on adding new modules to the toolkit, one of which is an Energy Resilience module. This module will incorporate energy production and consumption into the model, as well as endogenous dynamics in the energy sector (i.e., adoption of more resilient energy sources from responding optimally to economic incentives). The module will allow study of the interaction between building resilience to natural disasters and energy resilience, and the fiscal implications of alternative financing schemes.

Conclusion

Extreme weather events have become a feature of modern life. While they cannot be prevented, their negative economic impact can be reduced: by building resilient infrastructure, installing and using early warning systems, and investing in climate and environmental protection. Countries that take these actions will be better prepared to deal with natural disasters. The DIGNAD model and toolkit are designed to analyze these macro-critical issues across a wide variety of vulnerable countries and simulate the effect of various policies on the path of key macro-fiscal variables in a publicly-available, free-of-cost, user-friendly setting.

The model is constantly undergoing improvements to better capture emerging macro-critical issues based on users' demands and feedback.

References

Buffie, E. F., A. Berg, C. Pattillo, R. Portillo and L.-F. Zanna (2012) *Public Investment, Growth, and Debt Sustainability: Putting Together the Pieces*. IMF Working Paper 12/144. International Monetary Fund, Washington, DC.

Marto, R., C. Papageorgiou and V. Klyuev (2018) Building Resilience to Natural Disasters: An Application to Small Developing States. *Journal of Development Economics* 135, 574–586.