The Coalition of Finance Ministers for Climate Action

Informing economic modeling approaches for effective climate transitions

World Resources Institute (WRI)

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Topic: Addressing the climate policy questions facing Ministries of Finance: the economic and fiscal impacts the green transition

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The relevance of macroeconomic modeling for green transitions

The UNFCCC Paris Agreement aims to limit global temperature rise to well below 2°C above preindustrial levels, requiring extensive transformations across all economic sectors. These involve decoupling GDP from environmental degradation, energy use, material consumption, and greenhouse gas emissions. Climate change not only poses a significant challenge to economic growth, development, and social equity, but also creates an opportunity for a just transition that can generate trillions of dollars in net savings from mitigation and adaptation efforts.

Ministries of Finance need robust support to develop technically sound, scientifically credible, and achievable long-term, just climate transition strategies. These strategies must articulate a clear narrative of change, evaluate the economic, social, and environmental consequences of various public policies, and encourage private sector participation. Quantitative economic models (QEMs) are essential tools for identifying scenarios and constructing systematic economic analyses and narratives that can support MoFs in answering critical climate policy questions. The increasing use of QEMs in both public and private sectors underscores their importance.

However, QEMs vary in methodology, purpose, and applicability across different regions and periods. No single model is universally superior; the selection of model or models depends on the specific climate policy question and objective. For instance, integrated assessment models (IAMs) address climate impact questions but have been criticized for unrealistic damage functions. Microeconometric models are useful for fiscal economic policy considering income distribution questions but lack the comprehensive framework of general equilibrium models (GEMs) or stock-flow models.

System dynamic models, such as the green economy transition (GET) model, can inform Ministers of Finance in making sound decisions during green transitions. The GET model simulates the economic, social, and environmental impacts of different policy scenarios, enabling policymakers to assess the long-term benefits and trade-offs of investing in renewable energy, energy efficiency, and sustainable infrastructure. By providing a holistic view of the dynamic interactions between various sectors and the environment, system dynamics models help in formulating strategies that support sustainable economic growth while mitigating climate risks.

Choosing the appropriate model requires understanding its purpose, outputs, theoretical framework, data requirements and costs, and construction time. An ecosystem of models, allowing simultaneous use of different models within a consistent framework, is more effective. This necessitates building national and international modeling capacity to support climate transitions and strengthen public policy proposals.

QEMs also help construct positive narratives for climate transitions, analyzing the impact of sustainable investments on GDP, job creation, and income distribution. For example, assessing the effects of a green tax on gasoline or a carbon tax involves estimating potential fiscal revenue or a positive second dividend on income distribution, requiring microeconomic or GEMs.

Policy questions and modeling approaches: insights from WRI relevant to MoFs

A survey of World Resources Institute (WRI) staff across its 12 focus countries and regional offices highlighted key climate policy questions, development imperatives, and modeling choices. This survey is part of an ongoing WRI project to develop a blueprint to inform economic modeling of people, nature, and climate-aligned country development transitions, integral to WRI's five-year strategy. By gathering insights on salient policy questions, development imperatives, and narratives associated with the climate transition, this survey tapped into the informed perspectives of WRI directors and economists. The credibility and extensive experience of WRI, combined with its strong connections to political contexts and policymaking processes, are intended to give responses a relevant and actionable character. Respondents also drew upon sources such as official development plans, long-

term strategies, NDC commitments, and climate goals outlined in legislation, providing a comprehensive basis for economic analysis and modeling.

Understanding the macroeconomic impacts of decarbonization is a primary interest in the Institute's countries of focus, with 58% of WRI offices ranking "development direction" (which encompasses the required or feasible pace of decarbonization and different macroeconomic impacts of low-carbon development pathways) as a top climate transition policy category (Table 1). This underscores the need to understand the costs, revenues, and employment impacts of decarbonizing economies.

Table 1. Ranking of climate transition policy questions across WRI countries and regions, based on national development and climate strategies and plans

	Republic of Congo	Mexico	Brazil	China	United States	Kenya	Ethiopia	Democratic Republic of Congo	Colombia	Indonesia	India	Europe
Development direction (Should we decarbonize? How much will it cost? What will be the macroeconomic impacts?)	1	1	1	9	2	5	1		1	1	1	6
Impacts, risks, and costs of climate change on financial/fiscal stability?	5	2	2	1	6	8	4		3	5	4	
Impacts, risks, and costs of climate change on wellbeing, equity, and environment/sustainability?	2	9	6	7	1	3	3	1	6	6	5	2
Benefits and opportunities of climate change mitigation and adaptation policies.	3	1	7	3	4	2	5	2	4	4	6	4
Technology choices (Which technologies should we focus on? What will be the sectoral impacts?)	6	3	4	2	3	4	9	6	2	7	2	
Policy choices (Which policies are best to support our goals? Which policy packages are best?)	7	4	8	8	7	7	2	3		3	3	3
Policy design (How should we design this policy?)	8	6	9	4	8	9	6	4	5	2		
Relevance of adaptation to climate change?	4	5	10	6	9	6	7	5	7	8		1
Direct government/public investments	9	7	5	5	5	1	8		8	9		5
Other	10	10	3							10		

Note: The top and bottom three ranked climate transition policy question categories for each WRI office are shown in different shades of green and orange, respectively.

Other important policy questions include assessing the wider benefits and opportunities of climate mitigation and adaptation policies and their impacts on wellbeing, equity, sustainability, and financial stability. Table 2 provides an overview of different policy questions that received first or second ranking across different survey responses. These questions vary by country due to different economic, environmental, and political contexts. For instance, Ethiopia, India, Mexico, and the U.S. focus on the macroeconomic impacts of decarbonization, while Colombia emphasizes the overall costs and investments required.

WRI offices also expressed interest in developing more granular understandings of specific technologies and sectors. Renewable energy and electric vehicles (EVs) are prominent in China and the U.S., while green hydrogen and green steel, and biofuels and the bioeconomy are more relevant in countries such as India and Brazil, respectively. In the U.S., for instance, different WRI projects are exploring the economic impacts and workforce skills and training needs of the EV transition, due to the recent surge in EV-related investments spurred by different domestic manufacturing and labor market-related incentives in legislation such as the Inflation Reduction Act (IRA), and different federal and state-level agencies who are developing initiatives to train a skilled workforce for the EV industry.

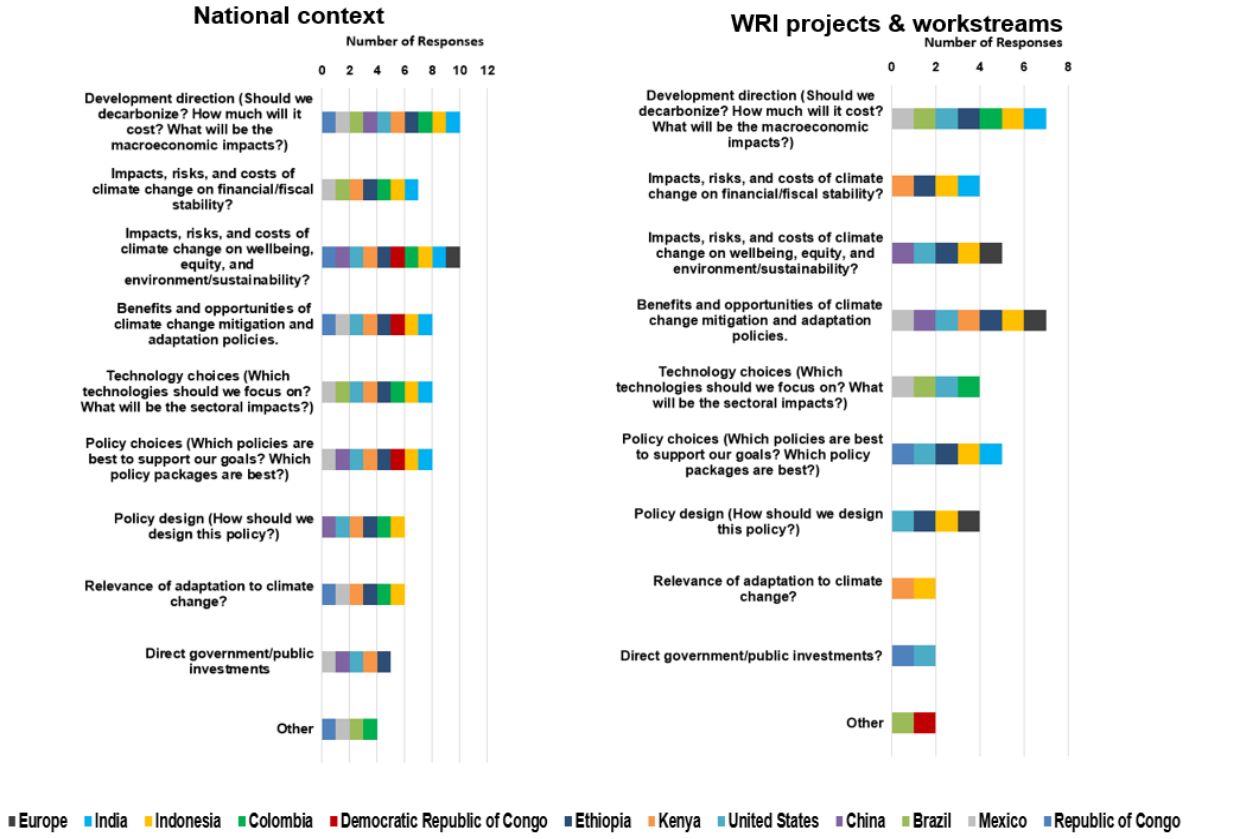
While these policy questions come from an informed interpretation of global and national climate agendas from economists within WRI offices, they have a direct bearing on Ministers of Finances' mandates as they directly impact economic stability, growth, and resilience. Understanding the macroeconomic effects of decarbonization, such as GDP impacts, fiscal risks, and opportunities, helps in formulating informed financial policies that align with sustainable development goals. Evaluating costs and benefits, investment needs, and sector-specific impacts ensures that fiscal policies foster economic transitions while mitigating risks associated with climate change. Also, addressing these questions may support strategies that attract private investment, and enhance national and regional economic resilience in the face of other global environmental challenges.

Table 2. Examples of climate transition policy questions which were ranked within the top two by survey responders (as shown in Table 1)

WRI Country/region	Examples of top priority policy questions
Republic of the Congo	Strengthening agricultural sector resilience for climate-smart production; Reducing coastal areas' vulnerability to climate change, especially in cities.
Mexico	GDP impact of scaling renewable energy for rural electricity consumption and public transportation EVs; Fiscal risks and opportunities of inaction vs. a diversified green economy.
Brazil	Opportunity cost of not decarbonizing by 2050; Land-use choices and combating deforestation.
China	Leveraging private funding with public aid; Co-benefits of renewable energy sectors and overseas investment in solar and wind.
United States	Impacts and costs of climate policies on different groups and equity considerations; Benefits of key technological transitions like EVs.
Kenya	Impact of public investment on financial stability, Government debt, and sector productivity; Public investment's effect on resilience, capital inflows, and economic expansion.
Ethiopia	Pathways to net zero by 2050 and macroeconomic impacts; Effects on employment and poverty levels.
Democratic Republic of the Congo	Improving climate resilience: early warning, hazard reduction, erosion control; Designing a national charter for environment and sustainable development.
Colombia	Costs of decarbonizing public transportation, a New Climate Economy for the Amazon, NDC 3.0 actions; Fiscal impacts of mobility transition and decarbonization pathways.
Indonesia	Cost-benefit analysis of economic transition; Climate change risks to coastal urban areas.
India	Pathways to net zero, GDP, and jobs impacts; Development of green hydrogen and green steel.
Europe	Costs of climate change and decarbonization, especially for renewable energy, nuclear power, and EVs; Investments needed for adaptation and restoration.

The survey results also reveal a wide coverage of climate transition policy questions across different contexts (Figure 1).

Figure 1. Relevant climate policy questions in WRI countries and regions



Modeling needs and recommendations

WRI offices are implementing a diverse range of models beyond mainstream frameworks such as IAMs (Figure 2). These include system dynamics/simulation models, policy appraisal tools, and GIS-based models. For example, WRI India and Indonesia use system dynamics models to evaluate the impacts of decarbonization on economic growth, jobs, and Government revenues across sectors.

Survey responses highlighted that WRI India's use of energy-economy system dynamics models, such as the India Energy Policy Simulator (EPS) and the Green Economy Model, has enabled the office to significantly contribute to interministerial committees on the macroeconomics of net zero pathways and the social impacts of the energy transition. EPS, an open-source model with a public web interface, allows users to assess the impacts of decarbonization policies across sectors through 2050, while the Green Economy Model models different scenarios of economic growth.

These different models offer various advantages and limitations. Aggregate or global models (e.g., IAMs) are suited for global debates and macroeconomic consequences, while microeconomic models (e.g., Almost Ideal Demand Systems (AIDS)) are better for addressing income distributional consequences. Input-Output models are more suitable for analyzing the relations among production sectors.

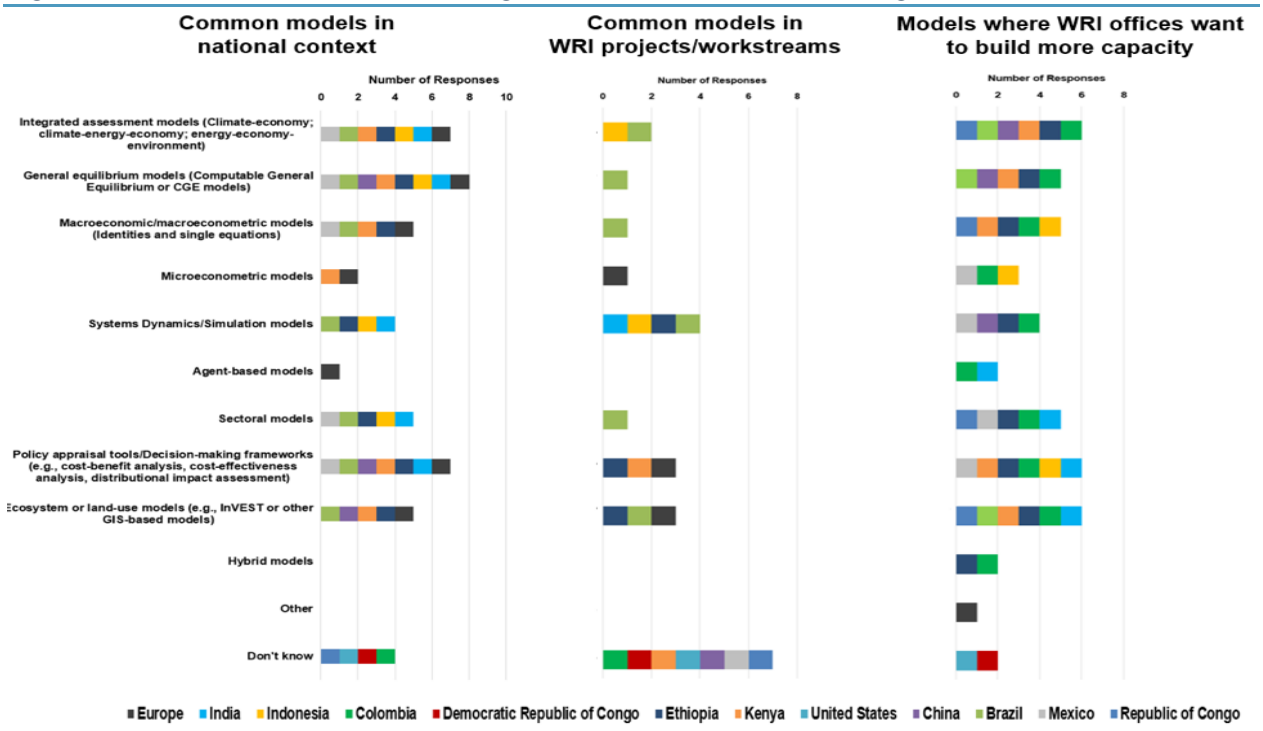
On its part, WRI Indonesia has applied system dynamics modeling to assess the macroeconomic impacts of low-carbon development pathways, supporting the Ministry of National Development Planning/Bappenas with Indonesia's Low-Carbon Development Initiative (LCDI). This modeling estimated and demonstrated the socioeconomic benefits (including employment, GDP growth,

valuation of restored ecosystem services, and reduced air pollution) that different net zero scenarios can offer, informing the Government's NDC targets ahead of COP 26.

Similarly, GIS-based models are used across WRI offices to better understand the geographic differences and distributional impacts of climate change, identifying land-use changes, ecosystem services, and biodiversity. Green transitions require restoration, preservation, and sustainable use of forests, ecosystems, biodiversity, and construction of green infrastructure (nature-based solutions). These models analyze the extent and condition of ecosystems and the monetary valuation of ecosystem services considering geographic locations. Multiple WRI offices (see Figure 2) are keen to apply such approaches, especially for understanding the geographic differences and implications of climate change impacts, such as the risk or cost of floods and heat waves in coastal or urban/rural areas, and distributional impacts such as changes in poverty and income levels in different regions.

In general, models run and, ideally, built in collaboration with Government officers have the highest chances of being maintained and utilized effectively. This collaboration ensures that the models are tailored to the specific needs and contexts of the Government, increasing their relevance and applicability. Additionally, it fosters a sense of ownership and capacity-building among Government Officers, making it more likely the models will be continuously updated and used in policymaking processes.

Figure 2. Common models and modeling needs in WRI countries and regions



To effectively support climate transitions, the following recommendations are made to Ministers of Finance:

1. Develop a comprehensive in-house modeling capacity: Invest in building national in-house capacity within MoFs and other key Ministries to use a variety of economic models. This ensures a harmonized framework for climate transition strategies and provides the ability to generate quantitative inputs and simulations for debates on alternative policy options. Developing this capacity allows governments to better understand valuable policy proposals from independent think tanks.
2. Adopt an ecosystem of models embracing the latest evidence around climate transformations: Utilize a combination of models tailored to specific policy questions and

contexts, ensuring consistent and comprehensive analysis. This approach provides the capacity to address diverse types of questions with more robust analyses and narratives. For instance, the European Union's use of various models, such as PRIMES and GAINS, has enabled comprehensive assessments of energy, climate, and air quality policies, leading to more informed and effective decision-making. Recent advancements underscore the benefits of system dynamics models, particularly in the context of transformational change. System dynamics models are especially effective for understanding complex, dynamic interactions within climate systems and their socioeconomic impacts. They excel in capturing feedback loops and time delays, which are crucial for analyzing long-term climate transitions and their implications. For example, studies have shown that system dynamics modeling has significantly improved policymaking by providing insights into the long-term effects of carbon pricing and renewable energy adoption. These models help policymakers anticipate the unintended consequences and adapt strategies over time, making them invaluable for navigating the complexities of climate transitions.

3. Focus on positive narratives: Use QEMs to construct narratives that highlight the benefits of climate transitions, such as sustainable investment impacts on GDP, the development of latent economic sectors, and job creation. This usage supports the construction of economic, social, and political consensus in favor of climate transition. Evidence from Indonesia's LCDI demonstrates that positive economic narratives around renewable energy investments and ecotourism can drive public and political support for ambitious climate policies. Incorporating beyond-GDP indicators, such as improvements in health and education outcomes, further strengthens these narratives by showcasing the broader benefits of climate action.
4. Evaluate the impacts of policies embracing beyond-GDP indicators: Employ models to assess the economic, social, and environmental consequences of various public policies, informing better "win-win" or "no-regret" decision-making and fostering private sector participation. Models can provide comprehensive information on the multiple consequences of alternative public policies, thereby contributing to a more informed decision-making process. Integrating beyond-GDP metrics allows for a more nuanced evaluation of policy impacts, ensuring that policies promote overall well-being and sustainability.
5. Monitor and adapt: Continuously update and refine models based on new data and changing circumstances, ensuring they remain relevant and effective tools for policy analysis. Regular updates to models ensure that policy recommendations are based on the most current and accurate information, allowing for adaptive and responsive economic planning in the face of evolving climate challenges.

References

Deaton, A., and J. Muellbauer (1980) An Almost Ideal Demand System. *American Economic Review* 70(3), 312–326.

Dell, M., B. F. Jones and B. A. Olken (2014) What Do We Learn from the Weather? The New Climate–Economy Literature. *Journal of Economic Literature* 52(3), 740–798.

Ekins, P., and S. Speck (2011) *Environmental Tax Reform. A Policy for Green Growth*., Oxford University Press.

IPCC (2014) *Cambio climático 2014: Informe de síntesis. Contribución de los Grupos de trabajo I, II y III al Quinto Informe de Evaluación del Grupo Intergubernamental de Expertos sobre el Cambio Climático*. Grupo Intergubernamental de Expertos sobre Cambio Climático. https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full_es.pdf.

Garrido, L., I. Suriany, I. Darliazi Yananto, E. Suarga, A. Wijaya, M. Davis, A. Harsono, K. Connolly and Y. Akopian (2021) *A Green Economy for a Net-Zero Future: How Indonesia Can Build Back Better after COVID-19 with the Low Carbon Development Initiative (LCDI)*. World Resources Institute. https://lcdi-indonesia.id/wp-content/uploads/2021/10/GE-Report-English-8-Oct-lowres.pdf.

Mercure, J-F, Knobloch, F., Pollitt H., Paroussos, L., Scrieciu, S. S., and R. Lewney (2019) Modelling Innovation and the Macroeconomics of Low-Carbon Transitions: Theory, Perspectives and Practical Use. *Climate Policy* 19(8), 1019–1037. https://doi.org/10.1080/14693062.2019.1617665.

Naciones Unidas (2015) *Acuerdo de París de la Convención Marco de las Naciones Unidas sobre el Cambio Climático (UNFCCC)*. https://www.refworld.org/es/leg/multilateraltreaty/un/2015/es/134497.

NGFS (2021) *Climate Scenarios for Central Banks and Supervisors.* Network for Greening the Financial System.

Pindyck, R. S. (2013) Climate Change Policy: What Do the Models Tell Us? *Journal of Economic Literature* 51(3), 860–872. https://doi.org/10.1257/jel.51.3.860.

Stern, N., Stiglitz, J. E., and C. Taylor (2021) *The Economics of Immense Risk, Urgent Action and Radical Change: Towards New Approaches to the Economics of Climate Change.* NBER Working Paper 28472.