The Coalition of Finance Ministers for Climate Action

The challenges of uncertainty in climate–economy modeling

Canada—Department of Finance

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: Specific analytical tools and approaches relevant to Ministries of Finance

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Uncertainty about how climate change will impact economies is a major challenge for economic modeling. First, there is the question of which climate futures are being discussed. The impacts associated with a scenario where global economies rapidly decarbonize might have large transition risks but avoid the worst physical impacts of climate change down the road. On the other extreme, a scenario where global action fails to limit climate change might feature status quo economies dealing with more severe physical risks. Furthermore, different assumptions about future technological progress and policy uncertainty about mitigation and adaptation actions will imply very different future market conditions for economic agents. For this reason, any attempts to estimate economic impacts will be scenario dependent and represent possible impacts should a particular climate future materialize.

Decisions about whether to buy an electric vehicle, explore for new oil deposits, or buy flood insurance all require agents to have some expectation about the future. Models that assume agents have perfect foresight about the climate scenario they are in will tend to underestimate the impacts of the transition. Agents who are making optimal decisions under greater uncertainty will tend to delay decisions or choose investments with shorter time horizons. However, what information can individuals use to form rational expectations about future climate impacts? What probabilities should be attached to the different possible climate scenarios and how much Knightian uncertainty (the unknown unknowns) exists?[1] This is not a new critique; however, it remains unresolved. Incorporating uncertainty into models would impact the relative benefits of different mitigation policies. Policies that reduce uncertainty and achieve policy objectives in all future conditions will be more beneficial than policies that must be fine-tuned to future conditions in order to obtain the desired outcomes.

Having a better understanding of the extent of climate uncertainty is also important, since it adds to the overall level of uncertainty in the global economy. Uncertainty about the future makes decision-making more difficult, which in turn affects the numerous macroeconomic variables monitored by Ministries of Finance, such as productivity, investment and savings behavior, borrowing costs, and stock market volatility.

The range of potential climate futures will remain large so long as it is unclear whether global actions will be sufficient to limit climate change. This naturally leads to a large amount of uncertainty, which will be a drag on the global economy. Strong early climate actions that decrease the likelihood of extreme climate futures will narrow the range, reduce uncertainty, and benefit the macroeconomy. Quantifying these impacts might change the timing of optimal climate policies. This could be especially important, since simple economic models with discounting often find the optimal policy is to delay costly actions to the last possible moment.

A first tangible step in addressing climate uncertainty in economic modeling would be to create and maintain a database of potential climate scenarios that includes estimates of their likelihood under different assumptions about global climate mitigation actions. This would allow researchers to assign probabilities to sensitivity analysis and make better recommendations for policies that have different outcomes across scenarios.

Reference

Knight, F. H. (1921) *Risk, Uncertainty and Profit*. Boston, MA: Houghton Mifflin.

1 There is an important distinction in economics between risk and uncertainty that is often attributed to Knight (1921). Risk represents situations when agents can form expectations across a range of possible known outcomes. On the other hand, Knight described uncertainty as situations that are "not susceptible to measurement." These are situations where agents cannot calculate likelihoods and/or cannot imagine possible outcomes. While progress has been made in incorporating the concept of risk into economic models, incorporating uncertainty, which is central to climate futures, has remained mostly unresolved.