CATO
RESEARCH BRIEFS
IN ECONOMIC POLICY

December 1, 2021 Number 278

The Economic Geography of Global Warming

By José-Luis Cruz, Princeton University; and Esteban Rossi-Hansberg, University of Chicago

The world is getting warmer due to carbon emissions generated by the economic activity of humans. Global carbon emissions will affect temperatures everywhere over long periods of time and in geographically different ways. What will be the impact of carbon emissions, and the implied changes in temperatures, on the world economy and on the economies of particular regions? How will individuals react to these changes, and how are these reactions impacted by their ability to migrate, trade, or invest and develop alternative centers of economic activity? What are the best policies to combat global warming, and what are the implications of these policies for different regions across the world? We propose and quantify a novel model to address these questions.

The nature of the global warming phenomenon determines the elements of our model. Global carbon emissions affect local temperatures around the world, so we want a model of the world economy. Because these effects are extremely different across regions, even within countries, we want a model with local geographic details of places where temperatures affect both the productivity of those residing in these locations and the living amenities of these locations. Individuals facing adverse temperature conditions that affect their welfare in a location will react by moving, trading with people in other locations, or developing centers of economic activity in areas that are not so heavily affected by warmer temperatures or that benefit from them. We also introduce both clean and carbon-based energy as inputs in production: in our model, fossil fuels create carbon dioxide emissions, which in turn affect global and local temperatures. Because global warming is a protracted phenomenon developing over hundreds of years and happening in a growing economy, we need a model that is dynamic and incorporates the implications of this growth on carbon emissions and adaptation over time. Such a model will also allow us to study and understand the implications of this phenomenon across locations. We also need to incorporate population changes by means of net birth rates that vary across regions with different incomes and temperatures.

With the model in hand, we then simulate the economy forward over several centuries and evaluate the economic

Editor, **JEFFREY MIRON**, Harvard University and Cato Institute.

consequences of global warming. This phenomenon is expected to have varied effects across different regions: the hottest regions in South America, Africa, India, and Australia are expected to experience welfare losses of 20 percent and the coldest regions in Alaska, Northern Canada, and Siberia to undergo welfare gains as high as 11 percent. On average, the world is expected to lose 6 percent in terms of welfare, although the exact number depends on how much individuals value the future. By 2200, the average loss in welfare is expected to be 10 percent and the average loss in output larger than 5 percent, although the uncertainty inherited from our estimations implies that the losses could be as high as 20 percent and 12 percent, respectively. The large uncertainty in average outcomes, however, does not translate into significant uncertainty on the geographic distribution of those losses. The relative distribution of losses is very similar in our baseline case compared with the worst- or best-case scenarios. Effects on amenities are particularly important for losses in Africa and gains at the most northern latitudes, while losses in productivity affect almost all regions south of the 30th parallel south.

Our evaluation of the effects of global warming emphasizes economic adaptation through migration, trade, and endogenous local innovation. We assess the importance of each of these adaptation channels by assessing the effect of increasing the cost of migrating, trading, or investing by a certain percent globally. If we increase migration costs by 25 percent throughout the world, the average cost of global warming rises by an additional 3 percent by the year 2200. Higher migration costs make global warming more costly for Africa but also for northern regions that benefit less from the influx of migrants. Increases in migration costs lead to significantly faster population growth as more people stay in poorer areas where they have more children. We find a substantially smaller impact from increases in trade costs compared with migration costs. The reason is that the impact of temperature is geographically correlated, and most trade is local. Innovation is somewhere in between: a rise in innovation costs has a large relative effect that benefits the coldest places but hurts the warmest ones significantly. On average, though, less innovation implies that regions in India and China, which will eventually be heavily affected by global warming, grow less, and so the world, on average, loses less from the rise in temperatures.

We also study taxes on carbon dioxide, subsidies on clean energy, and the importance of technologies that eliminate excess carbon from the atmosphere. Clean-energy subsidies have only a modest effect on carbon emissions and the corresponding evolution of global temperature, since although they generate switches toward clean energy, they also lead to a reduction in the price of fossil fuels, which results in more production and ultimately more energy use. These effects tend to cancel each other out.

Carbon taxes have a larger effect on carbon dioxide emissions and temperatures. The reduction in the use of fossil fuels leads to less carbon emissions, which results in lower temperatures that persist for hundreds of years. However, the reduction in carbon use also implies that more carbon is left unexploited on Earth, which yields lower future extraction costs. The implication is that carbon taxes primarily delay the use of the carbon on Earth rather than decrease its total use. This has the effect of flattening the temperature curve, with lower temperatures for long periods of time but with little impact over the very long run. Hence, the effects of carbon taxes on the environment are primarily concentrated in the next 100 years or so. Of course, this result also implies that carbon taxes can be particularly effective in combination with carbon abatement technologies. If these technologies are forthcoming, delaying carbon consumption has tremendously positive effects, since the effect of future emissions is abated using the new technology. Thus, our results strongly suggest that carbon taxes should be combined with incentives to invent effective abatement technologies. To use an analogy from the epidemiology literature, flattening an infection curve is particularly effective if a cure is forthcoming, but much less so otherwise.

NOTE

This research brief is based on José-Luis Cruz and Esteban Rossi-Hansberg, "The Economic Geography of Global Warming," October 2021, https://rossihansberg.economics.uchicago.edu/EGGW.pdf.