Climate science

Trade-offs for equitable climate policy assessed

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Computational models show that regionally varied prices for carbon emissions can greatly reduce the need for poor countries to receive financial assistance to tackle climate change, while still stabilizing global warming. **See p.261**

International agreements for tackling climate change face many challenges. One of the knottiest is how to allocate mitigation efforts fairly across nations, without increasing the overall global cost, and without asking poor countries to accept large amounts of financial assistance that raise concerns about infringements of national sovereignty. On page 261, Bauer *et al.*[1] report an analysis of the trade-off between cost and sovereignty for various international climate policies. They conclude that sovereignty concerns can be allayed substantially with only slightly higher global costs by using a strategy in which the carbon price — the charge per tonne of carbon dioxide emissions — is varied modestly to account for each country's ability to pay.

After decades of gridlock in climate diplomacy, the 2015 Paris agreement received support from nearly 200 countries for the collective goal of limiting global warming by the end of this century to well below 2°C above pre-industrial levels. The key to its success was that it provided much-needed flexibility for countries to make their own nationally determined contributions to reducing greenhouse-gas emissions, instead of setting targets through a centralized treaty, as was the case for the 1997 Kyoto Protocol (go.nature.com/3oa6uvl).

By allowing countries to tailor commitments to what can realistically be delivered, the Paris approach reflects the United Nations' equity principle of 'common but differentiated responsibilities and respective capabilities'. It also reduces the need for financial transfer — the provision of money for poor countries to help them tackle climate change and to compensate for the negative economic consequences of mitigating global warming. Reducing this need is politically beneficial for poor countries because they sometimes perceive a heavy reliance on international financial transfer as undermining their national sovereignty. However, the Paris approach could be more expensive overall than the idealized strategy in which all countries pay a uniform carbon price, because emissions might not be reduced in the places in which it is cheapest to do this. The benefits of the Paris approach for feasibility, equity and sovereignty therefore come at the cost of economic inefficiencies.

Bauer *et al.* quantify the trade-offs between the global cost of climate mitigation (low cost equates to high economic efficiency) and the amount of international financial transfer needed (a proxy for concerns about sovereignty), to find a balance that would enable the 2 °C goal to be achieved with equitable effort-sharing — ensuring the same ratio of mitigation cost to income for all countries. The authors started by analysing two extreme policies. The first involves setting a globally uniform carbon price. This is the cheapest mitigation strategy overall, but requires large international transfer to ensure fair effort-sharing. The second policy is to have widely variable carbon prices across regions to ensure fair effort-sharing. This avoids transfers, but is less economically efficient globally.

The authors then explored a series of hybrid scenarios in between these two extremes, changing the degree of variation in regional carbon prices and calculating the international transfer required to achieve fair effort-sharing in each case. By combining and comparing these scenarios, the authors plot a curve that depicts the trade-off between global cost and financial transfers (see Fig. 3a of the paper[1]).

Bauer *et al.* show that small deviations from a globally uniform carbon price can achieve the 2°C goal with slightly higher mitigation costs, but much lower transfers. For instance, a modest regional variation in carbon prices with a standard deviation of US$14 per tonne in 2030 leads to a negligible increase in global mitigation costs, but an 18% reduction in required transfers. This implies that it is highly possible to deliver reasonably good outcomes for equity, economic efficiency and sovereignty, if policymakers are willing to deviate modestly from the economically most efficient strategy (a uniform carbon price).

The authors' findings highlight an advantage of the Paris approach: an equitable outcome can still be achieved when international transfers are reduced. At the 2009 United Nations Climate Change Conference, wealthy countries pledged $100 billion a year by 2020 to help developing countries tackle climate change. But the total amount collected from public and private sources in 2018 was less than $80 billion (go.nature.com/39gnts7). US President Donald Trump's decision to withdraw $2 billion that had been promised to the Green Climate Fund — the largest international fund for financing

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Figure 1 | Panel inspection at the Sumber Solar Plant in Mongolia. The construction of this solar plant was supported by the Green Climate Fund, the largest international fund for financing efforts to tackle global warming. However, a heavy reliance on such support is sometimes seen by poor countries as an infringement of their national sovereignty. Bauer *et al.*[1] report an analysis of climate policies that suggests a way to reduce the need for financial support.

efforts to mitigate and adapt to climate change (Fig. 1) — contributed to the shortfall. These realities demonstrate the uncertainties in mobilizing large-scale international transfer. By reducing the need for transfer, the Paris approach creates a more collaborative space for engaging both developed and developing countries in climate diplomacy.

Bauer and colleagues also point out plausible unintended consequences of the Paris approach for environmental sustainability. If the variation in carbon price across countries is large and the 2°C target remains the global objective, then developing countries might make only limited efforts to tackle climate change. This could push developed countries to adopt costly options, such as using a technology called bioenergy with carbon capture and storage (BECCS). The authors find that, in this scenario, countries that do not belong to the Organisation for Economic Co-operation and Development (OECD) will export bioenergy to OECD countries for use in BECCS — exacerbating deforestation and land-use intensification in the global south. The negative effects of BECCS on sustainability have received wide attention[2], but Bauer and co-workers' study emphasizes that these effects could worsen under the Paris approach, if mitigation efforts shift across countries.

The authors' assessment is based on the REMIND-MAgPIE computational model, which is one of the 'integrated assessment models' (IAMs) used by the Intergovernmental Panel on Climate Change to explore how different policy and technology pathways might affect global emissions and future climate[3,4]. Such models include representations of economic, energy and land systems, as well as the interactions between them. IAMs have been important analytical tools for designing climate policies[5], but Bauer and colleagues' study is exemplary in that an IAM is used to evaluate competing considerations faced by climate policymakers.

The new findings are a useful contribution to the high-level debate about the modes and objectives of climate policy, but crucial aspects of the modelling framework lack the granularity needed to inform real-world decision-making. For instance, the model considers just 12 world regions, whereas climate decisions are often made at national and subnational levels. Bauer *et al.* also use carbon prices as a proxy for climate policy, whereas policymakers need to choose from a range of low-carbon policies that vary in cost and feasibility.

Furthermore, countries decide their own carbon prices in the real world, whereas regional carbon prices are not allowed to vary independently in Bauer and colleagues' model. Instead, the authors use a rescaling method to adjust the whole set of regional carbon prices, to make computation easier. Finally, international transfer is modelled as the total financial flow from rich to poor countries, without taking into account specific financing mechanisms. However, a wide range of financing mechanisms exist, such as grants, subsidized loans and private finance, which involve different actors and terms. These limitations do not overshadow the value of the new work, but future efforts should engage model developers and users to bring IAMs closer to real-world problems.

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