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How to Respond to Interacting Climate Tipping Points

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How to respond to interacting climate tipping points

When setting carbon prices in a warming world, policymakers must be cognizant of the potential economic and environmental consequences of the risk of multiple, interrelated catastrophes.

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The optimal carbon price, whether a tax or price of a permit, must be set to the social cost of carbon[1,2]. This corresponds to the present discounted value of marginal damages to aggregate production resulting from higher temperatures in the future caused by emitting one additional ton of carbon today. This price is higher if society weighs future generations more, current generations are more willing to cut fossil fuel and sacrifice consumption to limit future warming, future generations are richer, and society is more risk averse. This approach to climate policy is concerned with damages around 2 to 3 ^{o}C, but ignores tale risks of catastrophes that rise rapidly at higher temperatures. The optimal carbon price then must be marked up[3], which can double the carbon price[4]. Society also must accumulate precautionary capital to cope when the calamity strikes[5]. But what happens when there is more than one tipping point and society has to anticipate the potential damage caused by multiple catastrophes? This issue is addressed by two studies in this issue of *Nature Climate Change*[6,7].

In the first study[6], Derek Lemoine and Christian Traeger[6] considers three tipping points in a simplified version of the integrated assessment model DICE-2007 (discussed in ref. 1): (i) a sudden increase in the climate sensitivity from 3 to 5 due to melting of the permafrost or retreating land ice sheets (implying that a doubling of carbon stock would lead to a rise in temperature of 5 instead of 3 ^{o}C); (ii) sudden halving of the rate of atmospheric CO_2 removal; and (iii) sudden increase in severity of production damages, say, due to weakening of the Atlantic conveyor belt. Policy makers use Bayesian learning of the unknown thresholds for each of these irreversible tips. Ignoring catastrophes requires a carbon price of 6 US \$/tCO_2. Allowing for all three catastrophes pushes up the price to 11 US \$/tCO_2 with the biggest contribution coming from the third tipping point leading to a sudden increase in production damages. As a result of the extra mitigation efforts, peak temperature is brought down from 4 to 3 ^{o}C. The optimal price of carbon adjustment is 50% higher than simply adding the effects of the individual tipping points, but this drops to less than a quarter in 2050. This effect is especially strong for the temperature and damage tipping points. The domino effect arises because crossing the threshold for the temperature tip or the carbon sink threshold boosts the risk of crossing the threshold for the damage tip, but not vice versa. Delaying carbon pricing is 60% more costly than without tipping points.

In the second study[7], Yongyang Cai, Timothy Lenton and Thomas Lontzek analyse a 16- instead of 4-dimensional version of DICE-2007. This study separates the coefficient of relative risk aversion from the coefficient of relative intergenerational inequality aversion (i.e., 3.07 and 0.67, whereas DICE-2007 has 1.45 and 1.45, respectively), and uses experts to calibrate the likelihood of each of five tipping points (reorganization of Atlantic conveyor belt, disintegration of Greenland Ice Sheet, collapse of West Antarctic Ice Sheet, dieback of Amazon rainforest, and a more persistent El-Niño regime) and how it depends on the state of the others[7]. It adds realism by allowing for slow and differential impacts of each catastrophe. Nevertheless, much bigger effects of tipping points are found: the optimal price of carbon increases from 15 to 116 US $/t$CO_2$. It is optimal to shut down carbon emissions by mid-century and cap temperature at 1.4 ^oC instead of 3 ^oC by 2100 in the baseline. In that case, there is only an 11% chance of one or more tipping points by 2100 compared with a 46% chance in the baseline. A big part of the reason for the eightfold rather than double the increase of the carbon price is due to using high relative risk aversion and low intergenerational inequality aversion. There are both positive and negative effects on the risk of other tipping points after a tip, which is why the net effect is a modest increase in the expected optimal price of carbon from 109 to 116 US $/t$CO_2$. However, some interactions in specific sample paths can have big effects on the expected price. Collapse of ice sheets might have already been crossed and are increasing the risk of reorganisation of the Atlantic conveyor belts, but this should nevertheless lead to intensified efforts to curb carbon emissions to cut the risk of other tipping points.

The more imminent risk of catastrophes at higher temperatures offers a better narrative than the usual approach that only considers costs at moderate degrees of global warming. It might trigger policy makers to finally take action to curb global warming. Such a change of discourse should also stimulate institutional investors to decarbonise their portfolios and avoid tail risks of climate catastrophes. Hedging strategies generate low-carbon portfolios that achieve the same return as the benchmark if there is no stepping up of climate policy but outperform the benchmark as soon as CO_2 is properly priced[8].

Future research is important. First, we need to know what can and should be done in terms of adaptation to prepare for potential calamities. This will probably involve precautionary saving, but also large-scale investment in water defences and other projects that weaken the impact of catastrophes. Second, research is needed to estimate the insurance society is willing to pay to limit the impact of catastrophes. One study finds that society is willing to pay a permanent tax of 7% if revenues are used to limit catastrophic losses to less than 15% (ref. 9). Third, one needs to allow for substitution between renewable energy and fossil fuel and for green technical progress on optimal climate policy. Fourth, one must allow for anticipation effects resulting from future scarcity of fossil fuel on climate policy. Delayed policies then lead to faster pump of oil and gas before it becomes more expensive, thus increasing global warming and the risk of tipping (the so-called Green Paradox). Finally, climate catastrophes interact with non-climate catastrophes such as mega-virus pandemics, nuclear terrorists, bio-terrorists, earthquakes or an asteroid hitting Earth. Cost-benefit analysis then yields ‘strange’ results as it is no longer necessarily optimal to give biggest priority to averting the catastrophe with the largest benefit/cost ratio[10]. Policies associated with different catastrophes are therefore inextricably intertwined.

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