Thinking about SG – an economic perspective

Governance of the Deployment of Solar Geoengineering Conference

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Preliminary and Confidential

We were asked to prepare a 1,000-word written brief after the conference. Here I reversed the order. I prepared a preliminary brief and it is now more efficient for me to just basically read from it.

Solar geoengineering (hereafter SG) is so relatively cheap to enact that it might effectively be undertaken unilaterally by one nation feeling itself under climate siege, to the detriment of other nations.[2] This SG externality is what I have called a *free-driver* problem because, without some form of international restraint, the country most in favor of SG can drive the SG outcome to the detriment of other countries. Essentially any determined country with even a medium-sized economy could, if unopposed, put up a geoengineered sunshade on its own, in answer to its own perceived need to lower global temperatures and change its own climate quickly. There are thus two serious public-goods problems involved in the economics of climate change: a free-rider problem with relatively expensive carbon abatement and a free-driver problem with relatively inexpensive SG.

The setting for this talk's problem of SG is a future world that has accumulated high enough greenhouse gas (GHG) concentrations for a long enough time that some countries are feeling under severe threat from climate changes. Perhaps Bangladesh is threatened by inundation and mass migration due to severely melting ice sheets. Or maybe Indian agriculture is collapsing from high temperatures and serious monsoon alterations. Or other countries like

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[2] Ballpark estimates of annual geoengineering costs of offsetting projected heating in this century might be in the neighborhood of around eight billion dollars or so.

China or the U.S. are concerned with damaging climate change for other reasons. Suppose that the governments of one or more such concerned countries feel themselves under such intense domestic political pressure to *do something* that they cannot wait for gradual diminishment of GHG emissions, but must come out in favor of geoengineering lower temperatures immediately (at very little direct deployment cost to them). Suppose that much of the rest of the world does not want the high level of SG that a free-driver solution implies. What is the outcome?

For concreteness here, I quantify the level of SG by the annual injection flow of stratospheric sulfur dioxide (SO_2). In essence, the world wants or needs a social choice mechanism to reconcile different preferences about where to dial the knob of SO_2 flow injections. Maybe it is worthwhile to set aside some time to think more abstractly about social-choice rules concerning where to dial the knob of SG flow levels that differentially impact parties having different interests.

I was asked to discuss what economic theory might contribute to an understanding of the governance problem of SG. My musings here will therefore be at a higher level of abstraction than most of us are accustomed to. I have a big-picture big-think message that some might view less charitably as a form of science fiction. I ask the audience to entertain a willing suspension of disbelief while I try to set out, as a thought experiment, a possible theoretical resolution of the SG knob-setting problem in the form of a particular social choice mechanism. I am asking: Is there any recognizable decision mechanism, however hypothetical, abstract, and seemingly unrealistic, that economic theory might suggest? At the very least I hope that this theoretical exercise is thought provoking and might stimulate other new ideas, perhaps along vaguely similar lines.

Imagine a hypothetical "World Climate Assembly" (WCA), which acts like a legislative general assembly. Each country is represented with voting weight perhaps, say, proportional to its population. The world starts off with some given flow-level of annual stratospheric SO_2 injection, which might be zero at the beginning. Consider an asymmetric supermajority voting system. I will use 3/4 as a numerical example, but the idea is more general. Any proposal to *increase* the level of geoengineering by dialing up the knob requires at least a 3/4 supermajority

of the general assembly. Any proposal to *decrease* the level of geoengineering by dialing down the knob requires at least a 1/4 "superminority" of the WCA.

This asymmetric supermajority voting system has (for me, at least) a certain intuitive appeal. Overdoing SG seems much more dangerous than underdoing SG because it represents a relatively much riskier strategy with a much more heavily weighted potential downside, so it should require a larger fraction of the vote to increase SG than to decrease SG. To up-dial SG is to move in the direction of an unknown and riskier strategy. To down-dial SG is to move in the direction of the known and less-risky strategy.

Now comes a question that economists love to pose and answer in applying economic theory to policy. Is there any coherent welfare story, which is not completely ridiculous, that could be used to justify the proposed policy? If we cannot find any such welfare story, then the proposed policy seems somewhat more suspect because it is based on heuristics alone. If we can find such a welfare story, then the proposed policy at least passes a minimal internal consistency check, although it may be legitimately criticized on many other grounds. (An example of this methodology is the idea that "free trade is a good policy," where economists since the time of Adam Smith can come up with a justifying welfare story that is not completely ridiculous, although it can be negated, for example, by declining-cost infant-industry arguments.)

For the WCA 3/4 voting rule, here is a sketch of an underlying welfare story. Each nation has a *different* most-preferred value of SG. The loss function for each nation is kinked at its most-preferred value of SG, with increased SG incurring *three* times as much loss as decreased SG for reasons having to do with the idea that overdone geoengineering is riskier and more horrifying, whereas underdone geoengineering is merely undesirable. Under these circumstances, the minimum total global welfare loss (or, equivalently, the maximum total global welfare gain) is realized by the above asymmetric WCA 3/4 supermajority voting rule. This is not a trivial result. Under certain non-ridiculous assumptions about each country's welfare function for SG, we can assert that a WCA supermajority voting rule maximizes total welfare.

I have used the example of a WCA 3/4 supermajority voting rule, but the number 3/4 generalizes. [3] A *less* stringent WCA supermajority 2/3 voting rule is welfare maximizing when increased SG incurs *two* times as much loss as decreased SG. A *more* stringent WCA supermajority 4/5 voting rule is welfare maximizing when increased SG incurs *four* times as much loss as decreased SG. And so forth.

Is this WCA proposal naïve? Yes, absolutely. To begin with, there are very few precedents of international voting outcomes applying with binding force. More generally, I am simplistically brushing aside a great many truly important aspects of the real world of international agreements. More specifically, why would a country voluntarily accede to a voting limitation on their SG sovereignty along the lines of the WCA proposal? I do not have a good answer to this question except to ask another question. What are the alternatives for SG governance and on what alternative theory are they based? Remember, a strict rules-based social-choice governance mechanism for dialing the knob on SG flows may look more appealing in a future world edging toward catastrophic climate extremes.

In conclusion, I hope that this theoretical WCA supermajority exercise is thought provoking and might stimulate other new ideas, perhaps along similar lines, but maybe even something altogether different.

Thank you for your attention.

[3] A full theoretical treatment is available in Weitzman (2015).