Confluence
INVESTMENT MANAGEMENT

Weekly Geopolitical Report

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The Geopolitics of Geoengineering

Climate change has been a major issue for the past two decades. An outgrowth of the environmental movement which began in the 1960s, there is growing concern that the atmospheric accumulation of greenhouse gases will lead to a catastrophic rise in temperatures and threaten human life on earth. Thus, there have been steady streams of proposals designed to reduce the burning of fossil fuels which are primarily responsible for accumulation of greenhouse gases, mostly carbon dioxide (CO_2).

We will not debate whether climate change (a) exists, and (b) is primarily caused by humans. Although these are worthwhile questions, our stance over the two and one-half years we have written these reports is to focus on what is likely to happen, not what policymakers "should" do. Because the preponderance of policymakers believes climate change is a threat, we assume that some policy changes in that direction are likely.

In this report, we will define geoengineering and examine the possibility that it will be used to combat the problem of climate change. Although the generally accepted method of reducing carbon emissions is through "clean energy," our perspective will be to discuss the economic and political costs of such a program which increases the attractiveness of geoengineering solutions. We will also look at how geoengineering increases the possibility of a geopolitical "event." As always, we will conclude the discussion with a view of how it affects markets.

Climate Change

Over the past 50 years, climatologists have reported a steady increase in temperatures that has coincided with a rise in CO_2 levels in the atmosphere. This has led the majority of scientists to postulate that this correlation is causal—in other words, rising CO_2 levels are causing temperatures to rise.

Rising temperatures clearly affect the world. Low lying areas risk being submerged. Weather patterns can be affected. Areas that were once fertile now face persistent droughts and other regions that were too cold for growing crops are now becoming arable.

Some research suggests that if CO_2 concentrations continue to rise that a "tipping point" may be reached where sudden climate change occurs. The movie *The Day After Tomorrow* detailed a situation where a warming planet suddenly affected ocean currents, bringing on a new ice age. Although generally panned as alarmist, there are concerns that the global rise in temperatures may be sudden and may lead to significant stresses on agriculture and society. Unfortunately, climatologists don't know when this might occur or how bad the situation will get.

One of the significant problems with CO_2 is that it tends to stay in the atmosphere for a long time, perhaps around a century.

Merely reducing the amount of the gas injected into the atmosphere won't significantly cut the current concentration. Thus, moving to "green energy" merely slows the accumulation; going to zero emissions just keeps the current concentration stable. In addition, any CO_2 emitted anywhere adds to the problem.

Understanding the "Free Rider"

When the economics of imperfect competition was being developed, analysts began working with the idea that firms watch each other's behavior in setting their own. Perfect competition assumes complete independence. Economists turned to game theory to try to forecast behavior.

One of the favorite "games" used in game theory is "prisoner's dilemma." The narrative of this game is that two prisoners are being questioned. The outcomes are shown below.

	(Silent)	**(Betray)**
Silent	**1 (1)**	**10 (0)**
Betray	**0 (10)**	**5 (5)**

The police arrest two suspects and don't have enough evidence to convict either one. Each prisoner is held in a separate room and offered leniency if they betray their partner. In other words, if prisoner A (without parentheses) betrays but prisoner B (with parentheses) does not, the former goes free and the latter is imprisoned for a decade. If they both betray, each goes to jail for five years. If they both are silent, each is given a misdemeanor and serves a year.

As a team, they are better off remaining silent. However, each individual faces a significant temptation to betray the other as the benefit of betrayal is great and the cost of silence high. The expected outcome is less than optimal; usually, we would expect both to betray and serve five years.

Policymakers face this problem with regards to climate change. The costs of failing to address climate change could be very high, but an individual nation benefits even more if some other country cuts carbon emissions. This is the classic "free rider" problem.

In this policy arena, countries have a great incentive to encourage others to cut carbon emissions while they themselves do not. Thus, the illusion of doing something to combat climate change is high; actually doing something about it is not. Why? The costs of cutting emissions are expensive.

The Intergovernmental Panel on Climate Change suggests that the costs of stabilizing (not reducing) the level of CO_2 through 2100 could cost between 0.4% and 5.0% of global GDP per year. Reducing the use of fossil fuels is likely to be very expensive and so getting my "neighbor" to bear most of the costs is a great temptation.

Virtually all economists will agree that the most effective way to reduce carbon emissions is to tax them. Of course, this works best because it is painful. Doubling or tripling the cost of electricity from fossil fuels will not only encourage the move to renewable resources but also support conservation. While these are laudable goals they also run the risk of turning a current officeholder into a private citizen.

Instead of the direct route of a carbon tax, governments have implemented "cap and trade" systems. In such programs, the regulator sets the level of "permissible" pollution and then assigns polluters how

much they can pollute. A firm that is generating more pollution can then trade with a cleaner firm for additional rights to pollute. The government can auction off these pollution rights as well which is a form of tax.

In theory, a cap and trade system could work as well as a carbon tax. However, when a simple program is replaced with a more complicated one, usually the goal is obscure the result. For example, the European Union has had a carbon cap and trade system for several years; the carbon price is set so low that it has had little impact on reducing carbon emissions. The Obama administration initially proposed a cap and trade system that was projected to generate $650 bn in revenue. This would suggest a program that would function as a tax. However, as the bill to create the program has moved through the House of Representatives, it appears that a significant amount of carbon credits will be given to utilities for free. The fear is that the initial proposal would raise the electricity rate to consumers which usually is the point of an energy tax!

Overall, cap and trade and other schemes are more designed to give the illusion of activity rather than to actually take steps to reduce carbon emissions. This occurs because no government wants to be on the side of providing the "free rider" his "ride."

At this point, despite dire warnings from scientists, governments will generally not move to restrict carbon emissions without solid evidence that all are going along. Thus, like the game "prisoner's dilemma," the world will end up with a less than optimal outcome.

Adding to the problem is the fact that scientists can't tell policymakers when the problem will become critical or how bad it will get, and so governments are forced to try to convince their citizens to make great sacrifices for a danger that may not be all that dreadful. Allowing another nation to continue to pollute and grow its GDP at a faster pace is simply unacceptable. Without the ability to enforce global rules with credible penalties, a worldwide agreement on reducing carbon emissions will simply devolve into policies designed to suggest action rather than accomplish real change.

The Allure of Geoengineering

While reducing CO_2 emissions is the scientifically preferable way of reducing the risk of climate change, there are other methods that might achieve the same outcome. The first would be to combat global warming by reducing solar radiation by reflecting sunlight back to the atmosphere. Generally speaking, about 30% of the sun's rays are reflected back into space. It has been postulated that adding a mere 1% to the amount of sun reflected into space would generally offset projected global warming over the next 30 years with no significant emissions abatement. The second would be to use methods that would absorb CO_2.

Methods to reflect the sun's rays range from the mostly proven to farfetched. On the proven side is based on the observable impact from volcanic aerosol. When major volcanic eruptions occur, sulfur and other debris are shot into the atmosphere. In the months that follow, there is a measurable reduction in temperature. The "stuff" in the sky reflects the sun's rays back into space, cooling the planet. Scientists have postulated that particles could be delivered to the upper atmosphere on a regular basis. This could create conditions similar to what occurs in a volcanic eruption. It is thought

that large aircraft or perhaps missiles could disperse reflective particles.

A second observation is that cloud cover reduces warming. Building cloud cover could be accomplished by using ships with specially fitted cooling towers to draw water vapor from the ocean and push the vapor skyward, creating clouds. Another idea is to cover land with reflective surfaces; grasses reflect more light than trees and snow reflects more than land. Covering building roofs with grasses or white surfaces would reflect light back into space.

On the level of "science fiction," some scientists believe that large solar reflectors could be positioned in space, above the level of communication and defense satellites, in order to reflect sunlight. This type of technology is likely years from development at the earliest.

The other general method, "carbon scrubbing," has two proposals. The first is to put iron filings into the ocean to spur the development of plankton. These organisms absorb CO_2 and thus stimulating their growth may reduce the level of this gas in the atmosphere. The creation of deep sea pumps might accomplish the same thing by bringing cold, organism rich water to the sea's surface. These organisms would be expected to absorb CO_2 as well.

What makes geoengineering so attractive is its low cost. Estimates suggest the cost would likely run 0.2% of global GDP per year. This low cost means that most of the OECD nations, along with China, Russia and India, could engage in geoengineering unilaterally. Perhaps even rich individuals could engage in geoengineering. Instead of painstaking negotiations, developing treaties, monitoring compliance, reducing global economics for a threat that may not actually develop, individuals or a few nations could simply "solve" the problem.

The Issue of Externalities

However, it might not be so simple. One of the problems with technology is that using certain techniques to solve a problem often have unexpected consequences. For example, in the early days of motoring, cars were more reliable and less polluting than horses. However, over time, the expansion of the automobile has caused developments, such as air pollution, urban and suburban sprawl, obesity, etc., that were not anticipated when the automobile was developed.

Scientists warn that all these methods may have unintended consequences. For example, computer simulations on particle dispersion suggest that it will likely change rainfall patterns. This could lead to areas that are currently fertile cropland becoming desert and vice versa. Another complication is that winters appear to be colder in higher latitude zones. Recently, occupants of Greenland have been reveling in the effects of global warming. They may not be so open to a return to colder temperatures.

Economists call these side effects from economic activity "externalities." These can be positive or negative. For example, the Americans with Disability Act forced cities to put "cutouts" in sidewalks so it would be easier for wheelchairs to enter crosswalks. Anyone who has pushed a baby stroller has also benefited from this action. This is known as a "positive" externality. When the impact is adverse, it is called a "negative" externality.

It is in the area of externalities where geopolitics has an impact. Assume a nation engages in geoengineering and it does cool the earth or absorb CO_2 but causes an

adverse change in weather in another nation. This could easily be a cause for war. For example, if India implemented geoengineering that slowed the rising of sea levels (a major issue for that nation) but caused an adverse climate event in Pakistan, it would not be hard to imagine that (a) Pakistan would view this as a hostile act and threaten to retaliate, and (b) India would be disinclined to compensate Pakistan for the damages.

The potential for negative externalities is high and these adverse outcomes will probably not be equally distributed. Clearly, the most dangerous outcome is one where the nation doing the geoengineering does not bear the costs of the adverse outcome. In addition, there could be other unexpected results. It is possible that the negative externality from a geoengineering act may not develop for a long time, decades or centuries. How could a nation be punished for something done in earlier generations?

Two Significant Threats

Perhaps the most dangerous element of geoengineering comes from the problem of moral hazard. If governments begin to believe that carbon reduction is simply not politically feasible without the threat of catastrophic climate change, the potential for a remedy via geoengineering will likely discourage policies to reduce carbon emissions. Policy would continue to follow the path seen thus far; it is better to give the appearance of taking action toward carbon reduction than to actually do it.

The second threat comes from differences in government structure. Since geoengineering carries the risk of unexpected outcomes, forcing broad debate on geoengineering policy is probably prudent. This debate is better suited for democratic governments with their competing interest groups. On the other hand, authoritarian governments are more likely to squelch internal debate. If these governments' perceived benefits from geoengineering outweigh the costs, authoritarian states could move quickly to unilaterally implement geoengineering. Prematurely launching a geoengineering program could lead to unexpected and potentially catastrophic outcomes.

Ramifications

Due to the problems inherent in "free riding," it is unlikely that global efforts to reduce carbon emissions will work. Instead, we will likely see a parade of laws and proposals that would work if implemented but won't be due to their costs. If climate change becomes a major problem, nations will push hard to get some other governments to endure the costs of carbon-reducing policies. Developing nations will push developed ones to cut emissions because of the "legacy" emissions the latter have created over the past 150 years. The developed nations won't tolerate losing their global economic dominance for the ephemeral goals of climate change. Thus, over time, look for geoengineering to become more broadly discussed as a solution to climate change.

In the short run, this means that industries that would be targeted to absorb the costs of policies designed to reduce carbon emissions are probably not in as much danger as they would appear. Energy, transportation, utilities and mining will probably not suffer significantly from policy-induced changes in consumption. It also means that it is highly unlikely that economic growth will be sacrificed to the goals of carbon emission reduction.

In the long run, if climate change does become catastrophic, we would expect companies engaged in geoengineering to

flourish. It is probably too early to begin investing in such schemes (firms are really non-existent at this point), although private equity is where these companies will emerge.

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