Carbon Regulations: Can Economic Science Determine Carbon Costs?

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One aspect of oil and energy demand is how carbon regulations will evolve. However, the work of MIT economist Robert Pindyck suggests that the world's fossil fuel driven technological structure provides many benefits to humankind which can be considered a sunk value of our existing economic system that would be lost if radical climate change policies are implemented. Even though global climate change due to carbon emissions will create environmental destruction and therefore challenges to the world's economy, nevertheless, there may be some benefits of climate change in many regions even as the costs of adaptation will be lower than expected in other regions. Also, the social rate of discount, which must be used to determine the present value of the future costs of carbon, may be high since fully two thirds of humanity live in developing countries where discount rates as high as 30% can be justified. Plus, developing countries need high economic growth to pay for food and necessities of their poorest people. Taken together, sunk costs, sunk values, the social discount rate and humanities need for growth suggest that there is no economic method for determining the costs of carbon emissions and thus no way to assign a carbon tax, nor a carbon cap.

GLOBAL CLIMATE CHANGE SCENARIOS

An interesting question within the environmental movement is whether you can prove in a court of law what the costs of carbon emissions are to society. For example, a court case could involve determining the social cost of carbon emissions, whereupon a slew of climate change scientists and economists are brought into a court room to prove scientifically what the environmental cost of carbon emissions are. The court case would show evidence that carbon induced climate change is anthropomorphic and will at some point cause detrimental geo-physical and biological changes to the Earth. However, the timing of any climate change, the magnitude of the physical and biological changes, the relationship between the physical and biological changes to social costs, and the social discount rate used to put a value on current carbon releases relative to distant carbon costs would all be difficult to estimate. This brings up the concepts of sunk costs, sunk values and the discount rate as espoused by Robert Pindyck (2007, 2012 and 2013).

What Pindyck shows is that carbon pollution creates very long run damage to the Earth such that the environmental damages transfer across decades and even centuries. However, the link between carbon buildup and the climate system is non-linear and so it is unclear at what level of carbon build-up geo-climate changes will occur, and by what magnitude and by when they will occur. Similarly, the relationship between climate and biological systems and the link between climate and the world's economic system is likewise non-linear. It is unclear, then, how to put a value on future geophysical environmental changes.

Consider two alternative scenarios. One climate scenario suggests that we will have devastating global warming, a melting of ice caps, a rise in sea levels, and very intense storms all of which will create huge human costs in terms of flooded cities, destroyed infrastructure and acidic seas. An alternative climate scenario suggests that global warming will melt glaciers causing fresher water in the seas that will alter the Atlantic Gulf Stream so that less warm ocean currents will thaw the North and South Poles, in which case, eventually, ice will build up at the tip of the Poles. The extra snow and ice reflect more sunlight which causes more cooling until the ice spreads towards the equator and a great ice age could ensue whereupon global oceans will recede. The eventual cold weather will hit normal bread baskets of the world reducing food supplies and causing starvation. The net economic effect of either scenario is hard to calculate. Cities may be flooded and then become high and dry without a port to use, kind of like ancient Ephesus.

However, it is easy to imagine within these two scenarios a kind of tug-of-war between the warming effects and the cooling effects. In this third scenario, the warming occurs, the ocean current changes, the poles cool, but the carbon keeps an ice age at bay. In that case, the effects of the carbon on the physical-biological system are difficult to determine. Likewise, you cannot predict how much flooding will occur or if breadbaskets will be lost or gained, or how dry or wet regions will become, all of which makes estimating climate change economic damages a difficult challenge.

SUNK VALUE

One issue regarding the estimation of the monetary value of potential climate damages due to carbon emissions is that of the sunk costs and sunk values in our existing technological system. Dixit and Pindyck (1994) show how sunk costs and sunk values can cause businesses to change slowly even though certain inputs into production and input and output prices can change fast. For example in the 1920s, after over a hundred years of using coal-fired steam locomotives, railroads had available new types of railroad train engines that could use electricity and diesel fuel, which were advantageous as they would cause less localized pollution and could run faster and with less refilling. However, since most of the train engines in those days were already coal-fired steam locomotives, there was a slow turnover from the steam locomotives to the diesel and electric train engines because coal infrastructure already existed along most railroad lines including coal bins, water tanks and steam locomotive mechanical shops. The coal system had a sunk cost, meaning there is no way to get back the costs invested in building up that infrastructure, but it also had a sunk value, meaning that since the coal infrastructure existed and was "free" to use and possessed much value, then that value was exploited for the benefit of society. Why invest in a changeover when you had a sunk value in existing infrastructure that worked well and had low marginal costs? Which is why coal-trains were used all the way until the 1950s.

Not only did coal fired steam locomotive infrastructure have the advantage of being in place and valuable, but railroads already had their people trained in how to run coal locomotives, which is a human capital sunk value, and they had a sunk value in existing supply chains. Plus, if a railroad made a huge investment into diesel or electric trains, it could not be sure which new technology would be the best. If you had invested the entire railroad's establishment into diesel trains, and then you found out that a new electric train technology would work better, you would not be able to switch again because you will have invested enormous new sunk costs into a new system that you will have to use for decades. So it is better to wait and see what the best technology is, before making the changeover, and that is what happened.

The moral of the story is, if you have a technological system in place and it works, then if you change that system, you lose all that sunk cost and sunk value just to invest heavily in a new and different type of capital infrastructure that may turn out to be less useful than even newer technology as it evolves. Therefore, what railroads did was to keep on using coal-fired locomotives until the need for normal repairs and upgrades were so high that either electric or diesel engines and their ancillary structure were relatively cheaper, whereupon the changeover began. That is, business keeps using existing technologies until it is clear that an upgrade can overcome the loss of the sunk value of the existing infrastructure.

This same idea is true today. It is costly to change our existing fossil fuel driven economy into a "green," low carbon economy because the existing technology has so much sunk value inherent in it. For example, the world currently has existing coal fired power plants, coal mines and general coal infrastructure, all of which has a sunk value that benefits society. The same goes for oil and gas infrastructure. The result is that giving up such infrastructure will mean losing the social benefits of that sunk value. If we outlaw the use of coal then all that sunk value of existing technologies and capital can no longer be used to help society, from creating jobs to increasing government programs for the poor to helping finance health care. Even if you put an emissions fee on the use of fossil fuels to reduce carbon emissions it would not necessarily overwhelm the inherent value of the continuing use of them.

Plus, there is a multiplier effect. If you stop using coal, it is not just a simple case of lost sunk value, you also lose the macroeconomic multiplier effect. A system with sunk value allows people to spend money on other goods and services in other industries which creates even more economic activity, on the order of four times the original value. In addition, more economic growth allows us to develop more technology and knowledge that also has a multiplier effect into the future. Less technological and knowledge growth today will also have a multiplier effect that reduces future technology and knowledge which reduces future economic growth and which reduces our future ability to cope with environmental changes, and that is an unknown cost of reducing carbon now.

Granted, carbon emissions will also have a multiplier effect on the environment for thousands of years into the future, but then you have to ask, how easy or difficult will it be to adapt to those environmental changes?

HUMAN ADAPTATION SCENARIOS

Assuming we can predict with any accuracy the future changes in the physical-biological system due to carbon build-up, then we need to predict the resulting costs to our future economic system. The difficulty inherent in climate change economic analysis, then, is estimating how environmental change inflicts economic costs, which in turn depends on how easily it will be to adapt and how costly those adaptations are. Indeed, technology may come up with ways to enhance positive effects of climate change and thereby reduce the negative costs of climate change on the economy. As one student suggests, we may be able to live in small virtual reality rooms anywhere in the world with only a minimal need for food, transportation and shelter, in which case technology can solve all our problems if we let it develop.

Probably, the food aspect is of paramount concern. As CO_2 increases, climates will warm or cool and weather patterns will change. Certain locations for agricultural production may become better food producers even as other locations may become worse food producers. Therefore, there can be gains as well as losses to food production such that even if one region becomes less productive agriculturally, there may be easy ways for technology to adapt and reduce the loss in productivity. Or alternatively, some regions will become so much more productive than expected due to their improved agricultural climate that they will easily compensate for the regions that lose their productivity. Or there could be a major net loss in food productivity.

On top of estimating costs of adaptations to a business as usual scenario, other factors may erupt long before we have to adapt to carbon induced climate change. For example, there is a good chance that peak oil will occur and the amount of oil available will be significantly reduced. Scientifically speaking, scenarios of peak oil must be included in the future economic estimates of losses of GDP due to climate change. The oil shock scenario in general can affect our entire economy, as it did to the Soviet Union, as Reynolds (2016) shows. This may cause a change in our economy, long before climate change arrives, and mean that climate costs themselves will be much lower than currently predicted. Plus, it is difficult to ascertain which carbon strategies are best to use and so changing the economy now with a carbon tax might push research and innovation into unhelpful directions. If much work goes into solar energy and battery technology say, due to a carbon tax, but then industry becomes more labor intensive in the future due to less oil, then the carbon tax may have pushed research and innovation into unhelpful directions.

Therefore, it is unclear how climate change challenges will manifest themselves given the many other future changes that can occur. What that means is that the loss of economic activity in the future is difficult to estimate and may be low. It may be the case that with less oil, food production will become more labor intensive, and the labor intensity of food production may make it easier or harder to adapt to climate change scenarios.

THE SOCIAL RATE OF DISCOUNT

When climate change will happen, is hard to gauge. Already there are effects in Alaska, such as harsher storms in the arctic, which are considered costs, but also more walrus gatherings near arctic villages, which could be considered benefits, although, the greatest interest is in large effects and costs that will occur in the distant future. This requires us to estimate a social discount rate in order to properly value those costs now. That is we need to estimate a present value of the future costs, and benefits, of carbon emissions in order to estimate a carbon emissions fee or even a carbon cap.

A social discount rate is an interest rate that reflects society's value of the present versus the future. One way to estimate this is to use the market rate of interest, which can be argued is close to 5%, or rates of return for companies in the mid-20th century which were 10%. However, due to the risks and taxes associated with private transformation, the real rate of return for companies could be well above 10%.

Even more interesting is personal time preferences. Lawrance (1991) shows that there is a wide disparity of time preference rates for white people in the top 5% of income, who have a personal time preference of 12%, and non-white people in the bottom fifth percentile, who have a personal time preference of 19%. Thus, personal discount rates for the poor tend to be higher than discount rates for the rich. This also means that developing countries, as opposed to OECD countries, will have different discount rates. Anyone who has lived or traveled in developing countries notices such things as how relatively dangerous driving in those countries is. For example, there may be a bump in the road that could cause a dangerous traffic problem. The money to fix the road, though, is needed for food and water for people and so only high rate of return road projects are initiated, suggesting that the social rate of discount in developing countries may be 30%.

Since two thirds of the world's population lives in developing countries, then 30% may indeed be the social discount rate. Furthermore, many developing countries would actually like to see the U.S. and the EU increase their economic growth more, by not inhibiting that growth with carbon taxes or regulations which helps developing economies to export more. However, if the social rate of discount is 30% then any adverse cost that happens 30 years from now is almost of no value today. For example if we have a $100 trillion future cost of global climate change in 30 years, that is a $38 billion present value cost today which is less than half the value of the damage of Hurricane Maria in 2017.

CONCLUSION

When businesses face input price increases or demand decreases, they tend not to suddenly change their labor, capital and supply chains. First, a business may have a large amount of sunk cost and sunk value invested in its existing human capital, real capital and suppliers that compel it to continue operating in its existing state in order to gain as much of that sunk value as possible. Second, the business cannot be sure that input prices or demand might not revert back to previous levels making a wholesale change in its business practice a loss making venture. Third, the business cannot be sure what new technologies and business environments will emerge such that if it tries to change too fast now, it will miss a better investment opportunity in the future. Therefore it refrains from changing. This implies that the world's current fossil fuel based technologies should not be radically changed as that will reduce the sunk value that the world can continue to reap from its current fossil fuel technologies. By exploiting that sunk value now, new and better knowledge and technology, such as nuclear fusion, can be had in the future that ultimately might work better than the current batch of renewable technology on offer. Plus, the social rate of discount needs to be viewed from the perspective of the poorest two thirds of the world, in developing countries, rather than from the perspective of the richest one third of people, which suggests a social rate of discount much higher than 10%. That means the social cost of carbon emissions could be very low or even zero.

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