How hot does it get in a world of classical economists?

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Economists often observe[1] that, if only nations would work together to impose a global carbon price, fully incorporating the "climate externality" of carbon dioxide emissions, then we would make much faster progress addressing climate change. But what would actually happen if they got their way?

Suppose that, from now on, we co-operate fully, pricing carbon taking into account the interests of our fellow citizens and future generations. What happens then? At what temperature does global warming stop? In the paper "Drivers of peak warming in a consumption-maximising world"[2], I combine some very standard macro-economic tools with more recent insights into how the climate system responds to carbon dioxide emissions, to reach what may seem some rather counter-intuitive conclusions.

As economists like William Nordhaus have been arguing for years, it makes no sense to "spare no expense" to reduce emissions. Reducing emissions comes at a cost. So the ideal (classical economic) climate scenario is one in which emissions are reduced until the benefits of emitting one more tonne of carbon dioxide are just outweighed by the harm that tonne will do if it is dumped into the atmosphere.

So far, standard stuff – although any discussion of weighing up uncertain costs and benefits across different generations is still controversial. The new element in this paper is the now-familiar observation that carbon dioxide accumulates in the climate system, so every tonne emitted has an essentially permanent impact unless it is artificially scrubbed out of the atmosphere again.

In a perfectly rational world, we eliminate the most profligate uses of fossil carbon first: better home insulation, for example, almost pays for itself. But as we reduce emissions, the cost of getting rid of the next tonne rises inexorably, as we run up against uses of fossil carbon for which there are no cost-effective substitutes, like cement production or many transport fuels today. If this increase were to continue indefinitely, then emissions would never fall to zero, and the world would never stop warming, because the economic benefit of emitting just one more tonne would always outweigh the environmental cost.

Of course, future generations might decide to reduce emissions to below the level indicated by a cold-hearted cost-benefit analysis. They would be fully within their rights to do so: but we cannot base climate policy today on the assumption that they will be so "irrationally selfless", particularly when we ourselves appear to be inclined otherwise.

Fortunately, this rather depressing prospect omits the fact that, eventually, it will become cost-effective to capture carbon dioxide back out of the air and dispose of it, either underground, or in the oceans, or even by turning it back into carbonate rock, rather than leave it in the atmosphere continuing to harm the climate. The cost of large-scale carbon dioxide disposal turns out, unsurprisingly, to be critical to peak warming: with the middle-of-the-range numbers used in this paper, I find that unless we can get this cost below $200/tonne of carbon dioxide, then stabilising temperatures below 2°C will require truly heroic levels of self-sacrifice by future generations. Early investment is critical to minimising this cost, because most of the cheapest options, like underground storage, will take decades to develop and gain public acceptability.

This matters, because of the billions being spent on combatting climate change, only a tiny fraction is remotely relevant to large-scale carbon dioxide disposal. Renewable and nuclear energy are at best only a substitute for some current uses of fossil carbon. Neither is a true “backstop technology” that is capable of getting emissions to zero. And the UK has just pulled out of investing in carbon capture and sequestration, which is the necessary first step to large-scale carbon dioxide disposal.

This does not mean that all the money spent today on reducing emissions is wasted. But it does mean we should take a hard look at some of it. Anderson and Bows[3] argue that it may be necessary to make significant sacrifices to economic growth to avoid dangerous climate change. But, this new paper shows, paying too much for emission reductions could actually be counterproductive if it impairs the willingness and ability of future generations to reduce emissions to zero. Instead, we need to look at the impact of emission reduction measures on the so-called “carbon intensity of growth”: rather than reducing emissions at any cost, we should be aiming to maximise the ratio g/E, or the rate of growth g we achieve for a given rate of emission E.

Most economists agree that, above a certain level, increasing government expenditure reduces economic growth. Bergh and Henrekson[4] estimate that a 10% increase in government expenditure reduces growth by 0.5-1% in developed economies. So if G is the rate of government spending, $dg/dG \approx 0.075/G$. If G is used to “buy” emission reductions in a pure subsidy regime at a “cost of carbon” c per tonne of carbon dioxide avoided, then $dE/dG = 1/c$.

Hence government spending only reduces the carbon intensity of growth, or increases the ratio g/E, if[5] the cost of carbon is less than $c^* = gG/(0.075E)$. Plugging in numbers[6] for the world as a whole (and noting that Bergh and Henrekson’s analysis applied to developed economies) gives a value of $c^* = \$140/\text{tCO}_2$.

Interestingly, the effective “cost of carbon” paid by some emission reduction measures[7] exceeds this amount. How individual measures actually affect growth depends on what is being subsidised and how it is paid for: subsidies that encourage research and development may increase economic growth[8], unlike subsidies for mature technologies. But unless they are reducing the cost of carbon dioxide disposal, then the question of whether some government spending on climate change may ultimately be making the problem worse needs to be asked, and this new paper provides a framework for answering it.

This briefing reflects the view of the author, and does not necessarily reflect the position of the Oxford Martin School or the University of Oxford.

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[1] See, e.g., Nordhaus, W. D. (2013). "The Climate Casino". Yale University Press.
[2] Allen, M. R. (2016), Drivers of peak warming in a consumption-maximising world, *Nature Climate Change*, DOI 10.1038/nclimate2977
[3] http://kevinanderson.info/blog/avoiding-dangerous-climate-change-demands-de-growth-strategies-from-wealthier-nations/
[4] Bergh, A. and Henrekson, M. (2011) Government size and growth: a survey and interpretation of the evidence, *Journal of Economic Surveys* 25: 872–897
[5] $\frac{d}{dG}\left(\frac{g}{E}\right) = \left(E\frac{dg}{dG} - g\frac{dE}{dG}\right)/E^2 = \left(\frac{0.075E}{G} - \frac{g}{c}\right)/E^2 > 0$ only if $c > gG/(0.075E)$
[6] $G = \$13$ trillion/year, $E = 38$ GtCO_2/year, $g = 0.03$/year
[7] OECD (2013), “Effective Carbon Prices”, DOI 10.1787/9789264196964-en
[8] Romer, P. M., Endogenous technological change, *J. Political Econ.* 98: S71-S102