

The Kyoto Protocol and the Statistical Problem with CO₂ Emissions

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“About 300 years ago, a Flat Earth Society was founded by those who did not believe the world was round. That society still exists; it probably has about a dozen members.” Dr R K Pachauri, Chairman of the IPCC, when asked about criticisms of accepted global warming theory on 20 Feb. 2003.

The Kyoto Protocol opened for signature soon after the Conference of Parties meeting (COP III) for the UN Framework Convention on Climate Change (UNFCCC) which approved the treaty in December 1997. It is still just short of the ratifications which are required to bring it into effect, and it has soaked up many hundreds of millions of dollars to bring it to this almost final stage of parturition.

The essential purpose of the Kyoto Protocol is to establish a global regime of de-carbonisation, a regime which can be described as one designed to increase, through international legal instruments and the use of trade sanctions as an enforcement mechanism, the rate of decline of carbon intensity in the economic life of the world's peoples which has been manifest since the 1850s.

US President George W Bush formally announced that the US would not ratify Kyoto in April 2001. More than a year later, the Australian Prime Minister, John Howard, in an answer to a question in the House of Representatives on 5 June 2002, followed suit. Both political leaders have been under sustained pressure to resile from these positions since then. Neither leader shows any sign of doing so.

The Kyoto Protocol is unique amongst international treaties in that its legitimacy is based on a chain of scientific and socio-economic hypotheses. These hypotheses and their interconnectedness, is shown diagrammatically in Figure 1.

Much has been written about the validity of the climate models symbolised in the box labelled 'General Circulation Models'. These models use for their input data a range of atmospheric concentrations of carbon dioxide during the next century, and predict a range of global temperature outcomes as a consequence. When it issued its Third Assessment Report in January 2001, the Intergovernmental Panel on Climate Change (IPCC) - a body established in 1988 by the World Meteorological Organisation (WMO) and the United Nations Environment Panel (UNEP) - predicted global temperature increases by 2100 of between 1.4 and 5.8 degrees Celsius as a consequence of mankind's consumption of fossil fuels. These figures, (but mostly the higher figure) have provided ammunition for critics of President Bush and Prime Minister Howard for their refusal to ratify the Kyoto Protocol. In particular, it is noteworthy that in the US, where there is an intense debate on America's role as the world's hegemon, and where commentators are increasingly voicing concerns about US unilateralism, the Kyoto Protocol and the International Court of Justice are almost always

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cited as examples of irrational unilateralism which are offensive to the ‘international community’ and which compound America’s difficulties with its allies abroad.²

A number of eminent climate scientists³ have poured scorn on the claims made for the validity of the temperature predictions produced by these climate models. But the arguments used to justify this scorn are necessarily scientific arguments, and are almost always beyond the capacity of political leaders to comprehend, let alone to use in public debate. In every western country but the US, government controlled and/or funded scientific institutions, including universities, have fallen into line on global warming doctrine. Australia is in the unique situation of having created a quasi-government department, the Australian Greenhouse Office (AGO), with a budget of a quarter of a billion dollars, and with an incentive structure for all of its officials which is predicated wholly upon the establishment of the Kyoto Protocol. With such a huge sum of money at its disposal, other institutions are easily suborned, and so the official weight of government funded climatology and meteorology, supported by a broadsheet media which is largely faithful to the global warming doctrine, has remained largely impervious to mounting criticism from the growing Australian band of so-called sceptics.

In the US, universities are still, in the main, beyond the reach of the imposition of official doctrine on scientific theories, and although the US EPA has been a stronghold of greenhouse orthodoxy, and private and well-funded foundations such as the Pew Foundation have been active in promoting global warming doctrine throughout the business community, a network of university based scientists and economists, combined with researchers in private think-tanks, have maintained a continuing counter-attack, particularly on the science front. And thus the “sceptics” have, over the years, been able to influence a number of key senators, congressmen and, most recently, officials within the current Bush Administration.

The reason behind the US Senate’s rejection of Kyoto in July 1997, President Bush’s refusal to ratify in March 2001, and Prime Minister Howard’s refusal in June 2002, was not so much based on scepticism about official greenhouse science, but upon concern for the economic consequences of even the limited de-carbonisation prescribed by the current Kyoto targets. Australia, in particular, has an energy intensive economy, in which low cost energy provides the base for exports of energy intensive products including metals, minerals, manufactures and farm products. To turn a low-cost energy based economy into a high energy cost economy would destroy the foundation of Australia’s international comparative advantage, a base that has been built up over fifty years. Every econometric study shows that reducing the consumption of fossil fuels by fiat, either through carbon taxes or through other methods of rationing, imposes economic burdens upon the nation which undertakes this policy. There

² e.g. Francis Fukuyama, The Bonython Lecture, October 2002, CIS, Sydney,

³ e.g. Dr Sallie Baliunas, Deputy Director of Mount Wilson Observatory and astro-physicist at Harvard Smithsonian Centre for Astro-physics:
Emeritus Professor Reid Bryson, University of Wisconsin
William R Kininmonth, Head of the Australian National Climate Centre, 1986-98:
Dr Richard S Lindzen, Alfred P Sloan Professor of Meteorology at MIT:
Dr Patrick J Michaels, Professor of Environmental Science at the University of Virginia:

are, inevitably, arguments about the extent of the burden, and about methods to ameliorate the pain which the burden will bring, but the reality of the burden is beyond argument.

The chain of argument described schematically in Fig. 1 is this.

1. The combination of world population growth and increasing global prosperity will increase anthropogenic emissions of CO₂ and other greenhouse gases (GHGs).
2. These emissions will build up in the atmosphere and lead to increasing atmospheric concentrations of carbon dioxide in particular and other GHGs generally.
3. These increasing concentrations will cause increasing entrapment of infra-red radiation from the earth's surface and thus generate rising global surface temperatures.
4. In addition it is often claimed (but not by the IPCC) that increasing temperatures will lead to the increasing frequency and severity of extreme weather events such as cyclones. Rising sea levels and the spread of tropical diseases are often added to the list of consequences of the consumption of fossil fuels.

Since de-carbonisation on a global scale is the primary ambition of the Kyoto protagonists, it is useful to consider at the outset the numbers involved. Although the carbon dioxide molecule is the perceived primary villain of the greenhouse story, all of the arithmetic concerning the carbon cycle is described in tonnes of carbon. Thus the present atmospheric concentration of CO₂ of 370 ppmv (parts per million by volume) is equivalent to 780 billion tonnes (gigatonnes) of carbon (GtC) stored in the atmosphere. Carbon stored in the oceans is estimated at 40,000 GtC; in soil, plants and animals at 2,000 GtC. The annual carbon flux between oceans and atmosphere is estimated at 90 GtC; the annual flux from plant respiration and decomposition about 60 GtC. Annual anthropogenic emissions from the burning of fossil fuels comprise about 6 GtC. It is this last figure, the 6 GtC, and the calculated accumulation of these emissions from 1990 until 2100, with which this paper is concerned. Since 1976 the annual increment of CO₂ measured in the atmosphere has, on average, been approx 1.5 ppmv, the equivalent of an increment of 3GtC. There have been wide variations in the annual increment. In 1983 the increase was 0.75 ppmv, an increment of 1.5 GtC, and in 1998, the year of the Indonesian fires (including peat fires in Kalimantan), the increment was 3 ppmv.

It is a curious fact that up until early 2002, no one thought it worth their while to look with a critical eye at the left hand boxes in Fig. 1, the procedures and methods by means of which assumptions about world population growth, economic growth leading to increases in GDP per capita, and the relationship between economic growth and energy production and consumption, led to predictions of global emissions of anthropogenic carbon dioxide over the next century. The reason for this neglect is, presumably, the apparent simplicity of the task. At first sight it does not seem too difficult to lay down some population growth estimates, some economic growth estimates, some carbon intensity estimates, on a country by country basis, and obtain some results which would span a variety of assumptions about these parameters. The IPCC's Special Report on Emissions Scenarios (SRES) contains 40 such scenarios and it was almost universally assumed that this spread of results would encompass the likely range of low to high CO₂ emission outcomes.

However, now that the SRES results and the methodology used in obtaining them has (for the first time) come under serious external scrutiny, it has become clear that reasonable and coherent estimates of economic growth, on a country by country basis, are very difficult things to produce. The UN regularly produces population growth projections using a range of

assumptions, and medium term economic growth forecasts are produced by the IMF and the World Bank, but they do not extend very far into the future (2015 in the case of the World Bank).

A particular study, one which is noteworthy in this context, was produced in 1998 by the International Institute of Applied Systems Analysis (IIASA) based in Vienna, in conjunction with the World Energy Council (WEC). The study was entitled *Global Energy Perspectives*; it analysed future energy usage and options, and Professor Nebojsa Nakicenovic of the IIASA was the lead author. Professor Nakicenovic was also the lead author of the IPCC's Special Report on Emissions Scenarios (SRES) which is the focus of the arguments discussed in this paper.

Why, then, did Ian Castles, a former Australian Government official,⁴ with internationally recognised expertise as a statistician and an economist, think it worth his while in early 2002 to cast an enquiring eye upon the statistical work underlying the *Special Report on Emissions Scenarios* (SRES) which provided the predictions of anthropogenic carbon dioxide upon which the whole, vast Kyoto edifice is built?

Castles had not long previously engaged in a debate with James Wolfensohn, an Australian born but now naturalised American, who carries a heavy burden of responsibility as President of the World Bank. During 1999 and 2000, Wolfensohn had given a number of speeches in which he lamented the 'fact' that "20 percent of the world's population control 80 percent of the world's GDP"; the other 80 percent of then world's people therefore "have to" live on 20 percent of the world's output. Wolfensohn also claimed that the gap between the rich and the poor is increasing, not diminishing. In the foreword to the World Development Report for 2001 he writes "*Widening global disparities have increased the sense of deprivation and injustice for many*" a claim repeated in his Preface to World Development Indicators for 2002.

These claims are wrong. And they are based on a statistical fallacy which can produce bizarre results. The fallacy occurs when the comparative statistician uses foreign exchange rates as the basis for deciding relative values of consumption and prosperity in different countries, and for many years it has been accepted practice to use "purchasing power parity" as the basis for international comparisons of consumption. The difference between exchange rates and PPP methods is demonstrated every year when *The Economist* produces its "Big Mac Index", a table which shows the price of a Big Mac, around the world, in US dollars, using exchange rates to calculate the price. The difference in US dollar prices for a Big Mac in different parts of the world is substantial, but the value to the consumer of a Big Mac, whether in Moscow or Melbourne, Beijing or Bournemouth is, one has to assume, essentially the same.

Relative to its Big Mac PPP the euro is currently 8 percent overvalued against the US dollar, sterling is 21 percent overvalued, the Australian dollar is 34 percent undervalued, and the

⁴ Ian Castles AO, formerly Australian Statistician (1986-94); Secretary, Dept of Finance (1979-86); Member of the International Statistical Institute(1992); former President of the International Association of Official Statistics; Vice President of the Academy of Social Sciences in Australia (1995-2000).

Argentinian peso is 55 percent undervalued.

Castles' critique of Wolfensohn's statements and rhetoric was polite but firm. It was made clear that Wolfensohn, in using fallacies which the World Bank itself had rejected, is bringing the World Bank into disrepute. He is also doing considerable harm in reinforcing the propaganda of those NGOs which had tried to shut down the WTO Ministerial Meeting in Seattle in Dec 1999, and had brought chaos to the streets of Melbourne in September 2000 when they disrupted the meeting of the World Economic Forum.

Given that the exchange rate fallacy had captured the President of the World Bank, Castles wondered whether the same fallacy had captured the authors of the SRES report, and his concern was aroused when he noted the repetition in IPCC reports of the 'material errors' identified by the experts' report to the UN Statistical Commission on his statistical criticism of the UNDP *Human Development Report*.

By using foreign exchange rates in 1990 to calculate per capita GDPs across a large number of countries, the SRES statisticians who used 1990 as the baseline from which to project future CO₂ emissions had dramatically, but nonsensically, depressed consumption in every developing country, on average by a factor of three.

The fundamental assumption behind predictions of dramatically increasing global anthropogenic CO₂ emissions is the idea of "catch-up"; i.e. as the developing countries became more prosperous, their use of fossil fuels will increase significantly and their emissions will increase likewise.

Such an assumption appears eminently reasonable, but questions of 'how much' immediately arise, and at this point David Henderson⁵, joined the debate. He had followed closely Ian Castles' correspondence with IPCC Chairman Dr Rajendra Pachauri, and was puzzled by the impact of the exchange rate fallacy on the CO₂ emission figures. In Oct 2002 he wrote to Dr Pachauri in the following terms:-

In reading Ian's letters to you, I was puzzled to know how and why the choice of market exchange rates would affect the SRES scenario projections of total GDP and GDP per head for the 'Annex 2' (developing) countries over the period 1990-2100, projections which he views as unrealistically high. Why (I asked myself) should GDP projections for one group of countries alone be affected by their relative position, in relation to the rest of the world, in the base year from which the projections start out?

Having now looked at the scenarios, I think I have found an answer to that question.

⁵ David Henderson CMG, is now based in London where he is a visiting professor at the Westminster Business School. From 1984 to 1992 he was Head of the Economics and Statistics Department at the OECD in Paris, before which he had worked as an academic in Oxford and London, as a British civil servant, and in the World Bank. Since retiring from the OECD, David Henderson has worked at universities and think tanks in Paris, London, Brussels, Melbourne and Wellington.

The answer lies in the fact that the scenario projections start from an assumption that the 'Annex 2' countries - broadly, the developing countries -- will progressively and substantially gain ground over time, in terms of GDP per head, with respect to the 'Annex 1' group (which comprises the core OECD countries and the economies in transition). Each of the scenarios takes as a point of departure an estimate of the extent of this catching up, or convergence, over the whole period from 1990 to 2100. With this procedure, the choice between market exchange rates and PPP rates in the base year can make a substantial difference. This is because with the former, as opposed to the latter, there is significantly more ground to be made up: the initial divergence, the 'gap', is greater. Hence projected GDP in the poorer countries has to grow faster in order to achieve the postulated degree of convergence in later periods---with corresponding implications, other things being equal, for energy use and for CO2 emissions

What David Henderson had found was that the SRES modellers had worked backwards. They had decided that per capita incomes in the developing world would reach some sort of parity with the developed world by 2100. Having greatly suppressed per capita GDP figures for these countries through using foreign exchange rates instead of PPP in 1990, the economic growth rates they consequently forced upon the developing world in order to achieve a rough parity with the OECD countries by 2100, were beyond all historical experience. Henderson describes the process thus:

The B1 IMAGE scenario projects for the Annex 1 countries an increase in GDP per head, between 1990 and 2100, by a factor of just over 5. It further assumes that by 2100 the ratio of per capita GDP in those countries to that of the Annex 2 countries will have fallen to just over 1.8. In the 1990 base year this ratio (using market exchange rates) is put at 16.7. In order to move from this initial ratio of 16.7 to the postulated 1.8 in 2100, given the projected growth in the Annex 1 group, the total GDP of the Annex 2 countries is projected to rise, between 1990 and 2100, by a factor of just under 65.

The B1 IMAGE scenario is the “marker” scenario for the B1 family of scenarios, and forecasts a lower level of cumulative emissions from 1990 to 2100 than any of the other marker scenarios.

Estimates of economic growth in the past put US growth in per capita GDP during the 19th century as a fivefold increase, and in Japan during the 20th century as a twenty-fold increase. What the SRES modellers have done is propose a 65 fold increase over a 110 year period for the entire developing world, in order to produce a lower-range temperature increase.

It is, of course, at least arguable that the developing world could experience such an increase in living standards over the next century. But nothing like it has happened in the world before, and it surely behoves the IPCC modellers to give some reasons why such an unprecedented change in the economic history of the world could take place.

Although not directly relevant to the major fallacy of the SRES predictions, it is worth noting

the other anomalies which Castles and Henderson have discovered. For example, the B1T MESSAGE scenario (the 772GtC scenario) implies an average growth in global per capita CO₂ emissions of 1.2 per cent annually between 1999 and 2010. Since 1970 there has been no increase in per capita emissions globally. No explanation is offered for the sudden increase which is required for 2000-2010.

In terms of the global warming hypothesis in all its complexity, it can be said without much fear of contradiction that the carbon cycle which relates the stock of carbon in the atmosphere, the oceans, the biosphere, and the fluxes between them is not well understood, and that inputs into the atmosphere of CO₂ from volcanoes and ocean vents are likely to dwarf anthropogenic inputs during the next century.

Similarly, the capacity of large numerical models to simulate the behaviour of the atmosphere in all its infinite complexity, and to predict global temperatures as an output dependent solely upon atmospheric CO₂ concentrations, is an issue bitterly contested by very well qualified scientists.

But what these two eminent and independent economic statisticians have done is to show that even the apparently simple task of describing what the probable course of human development over the next century will produce in the way of CO₂ emissions, has proved well beyond the competence of the IPCC. Scenarios which require (as a by-product of the methodology employed in the analysis) South Africa to enjoy a GDP per capita figure of US \$364 thousand dollars by the year 2100, when the US itself will enjoy merely a GDP per capita figure of \$79 thousand dollars (both expressed in 1990 dollars) are not likely to inspire confidence in the competence of the scenario builders.

Even more curious is the fact that all of the projections of economic growth (and thus cumulative CO₂ emissions) that were produced by the SRES authors (with Professor Nakicenovic as lead author) exceeded those in the study produced in 1998 by Professor Nakicenovic in conjunction with the WEC. Without an explanation arguing the case for much higher GDP per capita growth rates for the SRES study than in the WEC study, critics have every right to be sceptical of the results.

Just as serious as the failure of the SRES modellers themselves to use accepted statistical procedures to produce reasonable and coherent outcomes, is the failure of the IPCC system of peer review to provide any protection against egregious error. 'Peer review' and 'scientific consensus' are the oft-quoted mantras that have been used by Dr Pachauri and others used to defend the climate models, their temperature predictions, and the IPCC processes generally. But in the case of the CO₂ emission scenarios, no government department of treasury, or finance, or economics, around the world, picked up these fundamental mistakes. That fact is just one facet of the wider problem in which departments of environment, around the world, together with their ministers, have been entrusted with responsibility for negotiating international treaties with huge economic and geo-political implications, and that departments such as trade, treasury and even foreign affairs, that were traditionally relied upon for advice, were often just left out of the bureaucratic loops.

The IPCC now has all the features of a well defended fortress, where 'peer review' means 'mate's review' and where advice and conclusions that do not fit the desired outcome, are

simply ignored.

Another example of the fortress defences at work comes from the field of entomology. An article entitled “Biting Back” in *New Scientist*, 23 September, 2000, began with these words:

“Malaria is marching north and global warming will make it worse, with mosquito armies colonising Europe, the US and highland regions of the South. That’s the picture being painted by a panel of UN scientists and several national governments. But for one of the world’s senior entomologists, this is not honest science. Paul Reiter, Chief Entomologist at the US Government’s Dengue Research Laboratories in Puerto Rico is afraid that *‘attributing the spread of malaria to global warming could detract from much-needed efforts to combat the disease itself and save lives now.’*”

Dr Reiter was asked the following question:

“Climate change researchers claim that an increase in extreme weather events will lead to more pools of stagnant water where mosquitos could breed and that higher temperatures kill mosquito predators . . .”

He replied:

“I find this very frustrating. Specialist in my field have had little voice in this debate. Take the IPCC which produced a global assessment of climate change in 1996. The bibliographies of the nine lead authors of the health section showed that between them they had only published six research papers on vector-borne diseases. Nevertheless, they devoted a third of their chapter to speculation on the future of those diseases. On the other hand, if you take those of us who don’t toe their line, you will find we have well over 600 publications on the subject. It beats me why the IPCC is given such credence while we are branded as sceptics”.

At the end of the article we have the following question and answer:

Q. *“But can you see why some scientists go on about climate change and infectious disease? It’s taken a long, hard fight to get the US to take global warming seriously, and scientists don’t want to throw that away. Even the slightest contrarian message can be used by the oil and auto lobby to obstruct efforts to address global warming . . .”*

A. *“You seem to be implying that the ends justifies the means. I disagree. The people who are most vociferous in this debate are simply not familiar with the epidemiology of diseases like malaria and dengue. My interest is in trying to keep the science straight. I love my subject and so do my colleagues. We are greatly concerned that a distorted picture has been presented to the public and is being used to drive policy.”*

Here, then, is another example, from a discipline far removed from comparative economic statistics, where serious questions have been raised concerning the scientific integrity of the IPCC processes.

It is a rare achievement that two former public servants have been able, through curiosity and

force of intellect, combined with international recognition of their professional standing, to threaten the legitimacy of a project with as much international political momentum as the Kyoto project. But the arguments which these two men have put together have the power of simplicity, comprehensibility, and the weight of reasonableness. No wonder Dr Pachauri is resorting to the epithet “flat-earthers” in his attempts to put them down.

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