JNphi

The Unreasonable Political Effectiveness of Mathematical Modelling

Susan Pockett

Abstract

Ever since Thomas Malthus used simple mathematics to model the evolution of food production vs the increasing human population of planet Earth and declared that we would very soon eat ourselves out of house and home, politicians have been falling hook, line and sinker for mathematical models. This paper examines how and why the mathematical modelling of complex systems has proved unreasonably effective in convincing mathematically illiterate politicians to take practical measures that have turned out to be disastrous. It then suggests that mathematical modelling of the human brain is not a good strategy to pursue.

Key Words: nature of mathematics, mathematical modelling, uses of models, epidemiology, climatology, economics, brain models

DOI: 10.5281/zenodo.10200253

Introduction

As a teenager, I admit to having regarded the subject of mathematics with suspicion and distaste. My problem was basically that I could not work out whether mathematics was a science, or an art – and neither could I make any of my teachers even understand the question. Was mathematics something that existed independently of humans and was out there waiting to be discovered (which in my view would have made its study a form of science)? Or was mathematics simply a human invention (which would have made it an art)? When I got to university, the fact that mathematics departments generally inhabited both science and arts faculties at the same time suggested that my confusion was widely shared. I continued to avoid the subject.

Sixty years later, when I finally got around to reading Eugene Wigner's famous paper "The unreasonable effectiveness of mathematics in the natural sciences" (Wigner, 1960), his conclusion seemed to settle the matter. As Wigner put it: "mathematics is the science of skillful operations with concepts and rules invented just for this purpose. The principal emphasis is on the invention of concepts". So, clearly Wigner was using the word 'science' here in the sense of 'body of knowledge about how to do' – as in 'the science of skillful oil painting.' Indeed, Wigner's further comment, that "Most more

advanced mathematical concepts, such as complex numbers, algebras, linear operators, Borel sets … were so devised that they are apt subjects on which the mathematician can demonstrate his ingenuity and sense of formal beauty. In fact, the definition of these concepts, with a realization that interesting and ingenious considerations could be applied to them, is the first demonstration of the ingeniousness of the mathematician who defines them" suggested that serious mathematicians are less interested in understanding the outside world than in demonstrating their own brilliance. I felt relief that, as someone who wanted to understand biology, I had not wasted too much time on maths.

But then, of course, Wigner went on to point out that mathematics is "unreasonably effective in the natural sciences" (by which he meant physics). However, physics is concerned mainly with simplified interactions between inanimate objects. And indeed, even then the mathematical modelling of such simplified interactions can be slippery, to the extent that a certain amount of "randomness" has to be invoked to drag the observed quantum mechanical relations between postulated quantum-sized objects into line with mathematical descriptions of them. And systems involving biological elements – epidemiology, climatology, economics – are much, much worse. Such systems are so many orders of magnitude more complex than the systems treated by physics that it is extraordinarily difficult to use mathematics to model them at all, let alone to do so with any degree of predictive accuracy.

The main problem to be solved in this regard is that when complex systems are considered, a fairly large number of assumptions have to be made, in order to simplify the system enough for any mathematical model at all to be constructed. And since very few people even realise that such assumptions have been made – let alone ask to see them – it is all too easy to hide the fact that the assumptions underlying any such model are almost always either completely untested, or (worse) obviously at odds with reality. Combine this with the fact that many if not most people (including virtually all politicians, who are generally lawyers by trade) are functionally illiterate in both science and mathematics – and will thus happily accept as "the science" anything a mathematical modeller tells them – and mathematical modelling becomes a priceless political tool.

The steps necessary to use this tool are simple;

1. Assume the truth of whatever you want the public to believe.
2. State this assumption in suitably mathematical terms.
3. Build a mathematical model around it.
4. Run the model.
5. Assert that the output of the model (a.k.a. "the science") proves your original assumption. (Yes, of course this is absolutely classic circular reasoning. But since nobody knows about steps 1 to 3, nobody will notice that).

6. Sit back and watch everyone believe your original assumption, because it has now been proven mathematically and therefore must be right.
7. Act on whatever you have programmed “the science” to show.
8. And with a bit of luck, by the time the political actions based on this paticular manifestation of “the science” have been shown to be catastrophically counterproductive, everyone will have forgotten that it was your model which caused those political actions in the first place.

The first three steps in this series must be done very quietly. Steps 4 – 8 can be trumpeted loudly (except that the word “assumption” must never be uttered). And yes, gentle reader, that's how it's done.

The rest of the present paper first lists three different situations in which this political tool has been – and still is being – used to great effect. It then suggests some places where mathematical modelling should probably NOT be tried in the future.

1. The Imperial College Epidemiological Model

Professor Neil Ferguson of Imperial College London has a splendid track record in this regard. The unreasonably astonishing thing about his situation is how British and other politicians have continued to believe his prognostications, despite a litany of erroneous earlier predictions. Dowd (2022) lists some of these, on his page 96:

> 2001: Predicted 150,000 people would die from foot and mouth disease. Actual number of deaths 200.
>
> 2002: predicted up to 156,000 deaths in the UK from Mad Cow Disease. Actual number of deaths 177.
>
> 2005: Predicted up to 200 million would die from bird flu. Actual number of deaths 282 over 6 years.
>
> 2009: Predicted 65,000 deaths from swine flu in UK. Actual number of deaths 45.
>
> 2020: Predicted up to 179,000 COVID deaths in Taiwan in first full year of covid pandemic. Actual number of deaths 10.

As Dowd puts it “Despite decades of dramatic and persistent failures, Neil Ferguson's prediction that as many as two million Americans would die from COVID in 2020 was used to justify lockdowns, school closures, social distancing and all that followed.”

So clearly this particular mathematical model does not and never has produced results consistent with reality. But then, of course, the counter measures taken on the basis of the model's over-the-top predictions have been given the credit for the reduced number of deaths.

That being said, this instance is not *necessarily* an example of the 8-step political scenario outlined above. Software engineer Denim (2020a, b) investigates Ferguson's computer code and says “Due to bugs, the code can produce very different results given identical inputs. They routinely act as if this is unimportant. This problem makes the code unusable for scientific purposes, given that a key part of the scientific method is the ability to replicate results. Without replication, the findings might not be real at all.”

So strictly speaking, this case illustrates that no political intent *need* be inferred in order to distrust the results of mathematical/computer modelling. Of the two major theories of history, the cock-up theory *can* operate independently of (as well as in concert with) the conspiracy theory. However, some level of conspiracy is suggested here both by the continued refusal of Imperial College to admit error and either withdraw or adequately fix the code – and by the point-blank refusal of governments around the world to consider the Imperial College group's dismal past performance when deciding whether or not to believe and act on their COVID predictions.

Following on from this, the (previously) most respected medical journal in the world, The Lancet, has published yet another mathematical model – this time written by a different set of Imperial College dwellers (Watson et al., 2022) and quite openly funded by a long series of dedicatedly globalist organisations, some with rather obvious financial conflicts of interest – claiming that “COVID-19 vaccination has substantially altered the course of the pandemic, saving tens of millions of lives globally.” This quite astoninshingly flawed paper once again fits earlier COVID-19 transmission models (constructed by the same Imperial College group) to both reported COVID deaths and excess mortality at various unspecified times during the WHO-declared pandemic – to purportedly calculate the number of deaths that COVID *would have* caused had no “vaccine” been developed at warp speed and administered by coercion. In doing so, it completely ignores the facts that :

- the transmission models have never been validated
- the numbers of 'official reported COVID deaths' used in this paper are embarrassingly unreliable, thanks to the combination of (a) the WHO's decision that no actual symptoms of COVID were required to declare someone a 'confirmed case' of the disease – just a cycle threshold of less than 40 on a PCR test that was never remotely fit for purpose and thus scored as 'confirmed cases' an unknown percentage of asymptomatic people who likely never harbored any coronavirus at all, let alone any virus capable of infecting others: and (b) the fact that virtually all 'COVID deaths' in the pre-vaccine era were suffered by elderly people who had been admitted to hospital on the verge of death from multiple unrelated comorbities anyway, but who tested positive on

admission (using the unsound PCR test) and whose subsequent demise was thus scored as a COVID death.

- Dowd (2022) for example, documents an epidemic of completely unexpected sudden deaths in previously healthy *young* people, immediately following injection of COVID "vaccines" (which, it should be noted, are not classical vaccines at all, but experimental gene-therapy shots fraudulently represented to the public as "safe and effective" vaccines).

However, since the magic words "Mathematical Modelling" appear in the title of the aforementioned Lancet paper – and because the editor-in-chief of this erstwhile globally respected medical journal permitted its publication – the paper was widely taken as proving that the experimental gene-therapy concoctions fraudulently shot into arms all over the world have not, in fact, killed or maimed an unacceptable number of their recipients, but on the contrary have *saved millions of lives* – and that more such shots would be even better.

At the time of writing it is too early to tell the ultimate outcome of this travesty of science and medical ethics, but I predict that it will not be pretty. And it was all justified using Professor Ferguson's appallingly unreliable mathematical model.

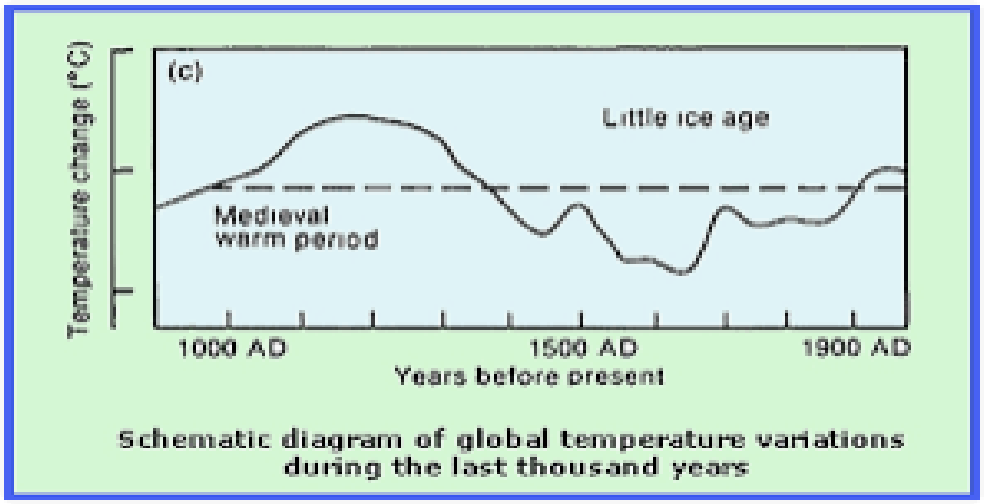
2. Mathematical Modelling of Climate Change

Exactly the same strategy has been used for many years now to convince people that the current warming trend in Earth's climate is (1) unprecedented (2) likely to fry us all within a few years and (3) caused by human production of "greenhouse gases".

Here there is no doubt that this is a case of deliberate fraud. In 1991, Alexander King and Bernard Schneider published a book called *"The First Global Revolution: A Report by the Council of the Club of Rome"* (now scrubbed from the internet) in which they say on p. 75 "*In searching for a new enemy to unite us, we came up with the idea that pollution, the threat of global warming, water shortages, famine and the like would fit the bill.*" [emphases added]. In the 1993 edition, they added "In their totality and their interactions, these phenomena do constitute a common threat which must be confronted by everyone together. But in designating these dangers as the enemy, we fall into the trap which we have already warned readers about, namely mistaking symptoms for causes. *All these dangers are caused by human intervention in natural processes*, and it is only through changed attitudes and behaviour that they can be overcome. The real enemy, then, is humanity itself." [emphasis added]. In other words, doom is upon us, it's all your fault and the only way to save the planet is for everyone to do as we tell them. (And oh, by the way, this means we really need a Global Government, run by us).

And then, the unreasonable political effectiveness of mathematics came into play. In order to convince people to "unite against" this "new enemy", it became necessary to show that *human intervention in natural processes* does indeed cause global warming. And therefore, since the only mechanism anyone could come up with by which humanity MIGHT be able to cause global warming was to spew lots of polluting gases into the air, it became necessary to show that global temperatures had increased dramatically after the First Industrial Revolution.

Well, this posed a bit of a problem. The trouble was that the First Assessment Report put out by the United Nations IPCC (Intergovernmental Panel on Climate Change) in 1990 had accepted unequivocally that global temperatures during the Medieval Period (from approx. AD 1000 to AD 1300) were significantly warmer than they are today. Grapes grew in London then. Greenland was … green. So Figure 7.1(c) on page 202 of that first IPCC report showed this:



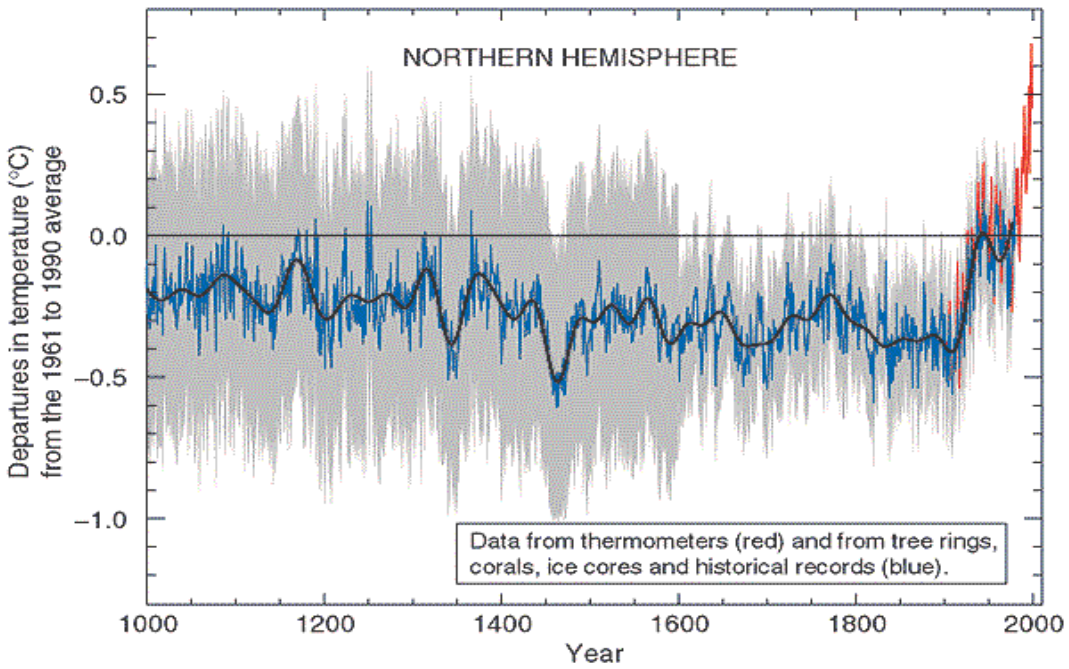
Schematic diagram of global temperature variations during the last thousand years

And the problem? This graph made it all too clear that (1) temperatures today are nothing out of the ordinary in historical terms – and (2) today's temperature is probably NOT significantly affected by the industrial release of CO_2. Why? Because there *was* no industrial release of CO_2 during the medieval period, yet the climate then was roughly 3°C warmer than it is now.

They couldn't just scrub this graph from the internet (the current go-to method of getting rid of inconvenient data) because there were too many hard copies out there. So then began the perversion of science that has characterised the "climate crisis" narrative ever since. The deliberate nature of the fraud is revealed by Deming's report a decade later (Deming, 2005) that after he had published a short 1995 article in the prestigious journal Science, he "… *gained significant credibility in the community of scientists working on climate change. They thought I was one of them, someone who would pervert science in the service of social and political causes. So, one of them let his guard*

down. A major person working in the area of climate change and global warming sent me an astonishing email that said "We have to get rid of the Medieval Warm Period"."

Well, all right then! So "get rid of the Medieval Warm Period" is exactly what a new cabal of well-paid 'climate scientists', peer reviewers and journal editors obediently did. In 1998, Michael Mann and colleagues published a paper in Nature saying that temperatures in the late 20th century were warmer than at any time since 1400 (Mann et al., 1998). OK, not controversial. But then, a year later, the same authors extended their analysis back to the year 1000 (Mann et al., 1999) – and poof – the Medieval Warm Period was gone. A well-known summary of the graph published in the 1999 paper is:



Medieval Warm Period? What Medieval Warm Period? The above graph was front and centre in the 2001 Third Assessment Report of the IPCC – and was subsequently sent by the Canadian government to all schools in Canada, with the catchy sobriquet "hockey stick." It was necessary to terrify the children.

But how was this miraculous disappearance of the Medieval Warm Period engineered? Well, by the judicious manipulation of mathematical modelling – or in other words, by the use of "lies, damned lies and statistics". Mann's refusal to make public either his data or the detail of his methodology became legendary (Ball 2014) and the issue soon blew up into an affair known as 'Climategate'. Eventually Mann was forced to release his data; but he has continued

to refuse point-blank to share the computer code he used to analyse them. Finally, it became clear that he had manipulated the underlying statistics to the extent that when random numbers were input into the methodology he had published, a hockey-stick shape was produced 99% of the time (McIntyre & McKitrick 2005 a,b). In summary, it can reasonably be said that this episode helped to (a) reduce public faith in the scientific objectivity of the IPCC (for futher evidence on how the IPCC routinely first publishes an alarmist Summary for Policy Makers, then edits their Scientific Report to fit the and (b) convince anyone who was paying attention that there is no "climate emergency" – and that Earth's climate, though constantly changing, is not significantly affected by anthropogenic CO_2. For a Declaration to this effect signed by 1,200 global climate scientists.

But of course, politicians bother about science only when "the science" supports their political agenda – and children believe whatever they're told by their teachers. So, for reasons the politicians choose not to disclose, they continue (while they are allowed by their adult public to do so) to impose draconian taxes and policies advantageous to only a few, all justified by firm statements that anthropogenic CO_2 is causing catastrophic global warming, which will fry us all unless we do what they tell us immediately. This narrative is greatly assisted by compliant school-teachers and by a news media interested only in horror stories (partly because the politicians reward such behaviour financially and partly because the boring old truth is just not click-bait). More to the point in the context of the present paper it is further supported by a raft of "climate models" all engineered (to the significant financial benefit of their makers) by way of the eight-step protocol detailed in the Introduction to the present paper.

Those interested in the actual mathematics involved in the hundreds of climate models that confidently predict how warm Earth will be in a hundred years (despite the fact that weather forecasters are notoriously unable to predict the weather accurately three days hence) can find such details in Ball et al (2011).

3. Economic Modelling of Free Trade

The two examples discussed so far show how mathematical modelling has been unreasonably effective in justifying draconian political action in the matters of (a) the arguably DoD-invented bioweapon known as Covid-19 and then the mRNA clot-shot promoted as a counter measure and (b) the so-called "climate crisis" (which is being used, among other things, in attempts to control pretty much all industrial food production on the planet (and to drive sales of electric vehicles on Earth. I mean, clearly electric vehicles will be needed when and if we colonise Mars, where there might well not BE any crude oil. But they are not necessary on Earth).

The present section of this paper moves on (or rather back) to discusses the age-old Free Trade agenda that has been essential for the implementation of the Globalist cabal's long desired “public-private partnerships.”

For economic justification, free trade relies to a certain extent on the 'neoclassical' economics of Friedrich von Hayek (1899 - 1992) of the London School of Economics and Milton Friedman (1912 - 2006) of the University of Chicago. These gentlemen's ideas were widely promoted in the 1970s and 80s by well-funded “think tanks” such as the Mont Pèlerin Society and the Adam Smith Institute. Specifically, with regard to free trade however, neoliberalism's less heralded economic engine comes from earlier, 'classical' economics: specifically, the Theory of Comparative Advantage advanced by English stockbroker David Ricardo (1772-1823).

The great classical economist Adam Smith (1723-1790) invented the Theory of Absolute Advantage. This says that if one country is a more efficient producer of a particular good than another country, both countries will benefit if each stick to producing what they're better at and imports what the other country is better at. For this to work, there has to be “free trade” – no barriers in terms of importing or exporting. Which all sounds perfectly sensible – until you subject it to a reality check. In the real world, it doesn't work. For example, New Zealand (NZ) has had a free trade agreement with Australia for decades. NZ is a more efficient dairy producer than Australia. Yet NZ observably imports Australian long-life milk. (In fact, this has become the only affordable way for Kiwi consumers to obtain lactose-free milk, since Fonterra apparently finds it so onerous to add a bit of lactase to some of its milk that it has doubled the price of fresh lactose-free full-cream milk in this country over the last few years and stopped producing lactose-free lite milk altogether). NZ is also a more efficient apple producer than Australia. Yet even after twice being told by the World Trade Organization to stop refusing shipments of NZ apples on various spurious grounds, Australia continues to put obstacles in the way of that trade.

Examples like these were obvious even in the 18th century, as David Ricardo realized while reading Adam Smith on his summer holiday one year. So, in an attempt to find a trade theory that did work in the real world, Ricardo came up with the Theory of Comparative Advantage, which is still much cited today. This produces the counterintuitive result that, even if New Zealand were more efficient than Australia at producing BOTH dairy products AND (say) cars, it might be advantageous for us to import dairy *if that freed up more resources for the production of cars*. Er … what?

Economists call the resources used to produce a good the “factors of production”. And they call whatever the producer must *give up* producing in order to produce a particular good, the “opportunity cost” of producing that good. So, the opportunity cost of producing

dairy would be the price of the cars we had to give up producing in order to produce more dairy.

Opportunity cost thus depends entirely on what other opportunities exist for using factors of production. According to the Theory of Comparative Advantage (a) the best strategy is always to minimize opportunity cost and (b) under free trade, the profit motive will naturally cause everyone to adopt the best strategy.

Not surprisingly, mathematical models of this theory generally produce results that strongly support free trade. The trouble is that once again, such models have to start from a number of assumptions. In this case these are (Fletcher, 2011):

1. Products are assumed to be identical across firms and across countries (no car or dairy product is assumed to be better than any other).

2. Labour is assumed to be homogeneous within a country but heterogeneous across countries (all Kiwis are equally able to produce either cars or milk and do so better than any Australian).

3. Transport costs are assumed to be non-existent.

4. Labour is assumed to be costlessly reallocated within countries but unable to move between countries.

5. Labour is assumed always to be fully employed.

6. The labour and goods markets are assumed to be perfectly competitive in both countries.

7. Firms are assumed to maximise profit, while consumers (workers) are assumed to maximise utility (aka happiness).

Well, it is fairly obvious that *none* of these assumptions actually holds in the real world. And, possibly for this reason, running the model produces results that are clearly contradicted by what happens in the real world. For example, the model says that even when country A is technologically superior to country B in both of two industries, free trade will cause one of these industries to go out of business in country A. It is not enough to have an absolute advantage: under free trade it is necessary to have a comparative advantage to guarantee continued production. This means that free trade *may* not result in a domestic industry's disappearing just because foreign firms pay their workers less. But of course, in the real world, this is exactly what *does* happen. NZ's manufacturing sector has been completely decimated over the last 45 years, exactly because protections have been removed and jobs *have* been off-shored to countries where workers are paid $1 a day. But not to worry, because according to the Theory of Comparative Advantage, if free trade drives a particular industry out of a country, this *must be* good for the country, because it means the country *must be* allocating its factors of production to something more profitable. Why? Because this is a basic assumption of the theory. OK,

so let us test the hypothesis and investigate what free trade has done to New Zealand's economy.

NZ now has at least 9 free trade agreements (FTAs) in force, involving Australia, much of Southeast Asia and Chile. With Australia, the 1966 NAFTA was replaced in 1983 by CER (Closer Economic Relations), which has since been continually updated and is now made up of more than 80 treaties, protocols and arrangements, going well beyond free trade in goods and services. FTAs with Singapore came into force in 2001; with Thailand in 2005; with the other three members of the Pacific Four (Brunei Darussalam - a small state on the north-west coast of Borneo), Chile and Singapore) in 2006; with China in 2008; with Malaysia in 2010; with Hong Kong in 2011; with ASEAN (Association of Southeast Asian Nations) in 2012 and with Korea in 2016.

And to cut a long story very short, NZ's balance of payments figures has gone from being uniformly zero – we didn't import more than we exported and we didn't export more than we imported – inexorably downwards since 1984, when the Labour Party introduced Free Trade by stealth. We have essentially been reduced from a self-sufficient country to a two-industry state (primary production and tourism, the only two industries that can't be off-shored). ALL of our once thriving manufacturing industries have been shipped out to countries where labour is much cheaper. And since the signing of the Transpacific Partnership Agreement (renamed to the Comprehensive and Progressive Transpacific Partnership Agreement after the Labour Party literally demonstrated in the street against it, along with a large slug of the population – and then renamed the agreement and signed it they day after they were elected by said population) the NZ government has had its power comprehensively stripped from it by international corporations. Do the corporation's products physically harm New Zealanders? Too bad – we are not allowed to ban those products, on pain of being sued by the corporation – and in suits settled not in NZ Courts, but in International tribunals comprising three judges, two of whom are appointed by the corporation. This means that in many respects, we already HAVE a Global Government – and one whose ONLY interest is in their own financial profits. The well-being of New Zealanders matter to them not a jot.

Did all this come about because of shonky mathematical models purporting to prove the excellence of Free Trade? Well, such models would certainly have helped. But the real issue is that nobody with any degree of power in this country has ever had the common sense and bravery to stand up against the prevailing narrative and point out the idiocy of utterly ceding our national sovereignty to a plethora of Free Trade agreements between the NZ government and various unelected 'legal persons' in the shape of multinational corporations. Such “public-private partnerships” are the very definition of Fascism (Roosevelt, 1938). They are shameful. And the fact that mathematical

models deliberately designed to show that they are a good idea convinced everyone who mattered that they WERE a good idea clearly shows that mathematical models are not to be trusted.

4. Mathematical Modeling of the Human Brain.

I hope that the above three sections have provided some insight into the difficulties and pitfalls associated with the mathematical modelling of complex systems. After fifty years of studying human and other mammalian brains and nervous systems, I have concluded that the human brain is far and away *the most* complex system in the known universe. Therefore, I am convinced that it would be fruitless, to the point of being actively counterproductive, to imagine that there is any real possibility of constructing a viable mathematical model of the human brain.

Several factors suggest that the currently pursued models of AI will never produce anything remotely capable of imitating, let alone surpassing the human brain, at anything other than a game with strictly defined rules, like chess.

Specifically

(1) Although it is universally accepted among AI aficionados that human brains are basically a wetware version of computer hardware, with the human mind cast as the software that runs on this biological CPU, even a modicum of critical thought suggests that this idea may be fundamentally mistaken (Pockett, 2014).

(2) Indeed, even for a simple voluntary movement, evidence suggests that the neuroscientific 'standard model', in which neural activity occurs sequentially in a series of discrete local areas each specialized for a particular function, may reflect the true situation less well than models in which large areas of brain shift simultaneously into and out of common activity states (Pockett et al., 2007).

(3) Further evidence shows that different individual humans have brains that achieve even simple perceptual-cognitive tasks in fundamentally different ways – none of which ways is easily described as resulting from the sort of neural net architecture used to construct hardware-based AI (Pockett et al., 2009).

Clever programmers can certainly program computers to do things. My point is that they will necessarily tell their computers to do those things in ways that are fundamentally different from the way in which a fully functioning human brain does them – because none of us yet knows even the principles by which a fully functioning human brain works.

Conclusion

I conclude that mathematical models in general should be regarded with the deepest suspicion. They are hypotheses at best – and before a hypothesis graduates to the status of scientific finding, it has to be rigorously tested. None of the models described in this paper has even remotely survived such a test. Therefore, mathematical models are NOT, as politicians tend to represent them, "the science". On the contrary, they are very likely to be outright scams, designed and constructed solely to demonstrate whatever their makers want the public to believe. In short, we should all stop trusting mathematical models.

References

Ball T, Johnson C, Hertzberg M, Olson A, Siddons A, Anderson C, Schreuder H and O'Sullivan J. Slaying the Sky Dragon; Death of the Greenhouse Gas Theory. Stairway Press, 2011; pp.355.

Ball T. The deliberate corruption of climate science. Stairway Press, Seattle, 2014.

Deming D. Global warming, the politicization of science and Michael Crichton's State of Fear. Journal of Scientific Exploration 2005;19(2): 247-256.

Denim S. Code review of Ferguson's model. 2020a. https://dailysceptic.org/2020/05/06/code-review-of-fergusons-model/

Denim S. Second analysis of Ferguson's model. 2020b. https://dailysceptic.org/2020/05/09/second-analysis-of-fergusons-model/

Dowd E. Cause Unknown: the epidemic of sudden deaths in 2021 and 2022. Skyhorse Publishing, Delaware, 2022

Fletcher I. Free trade doesn't work: what should replace it and why. Coalition for a prosperous America, Sheffield MA, 2011.

Mann, M.E. Bradley R.S. and Hughes M.K. Global-scale temperature patterns and climate forcing over the past six centuries. Nature (1998) 392 23 April 779- 787

Mann, M. E., Bradley, R. S., & Hughes, M. K. Northern Hemisphere temperatures during the past millennium: Inferences, uncertainties, and limitations. Geophysical Research Letters (1999) 26: 759-762

McIntyre S and McKitrick R. The M&M critique of the MBH98 northern hemisphere climate index: update and implications. Energy and Environment 2005a;16(1): 69-100.

McIntyre S and McKitrick R. Hockey sticks, principal components and spurious significance. Geophysical Research Letters 2005b;32:L03710, doi:10.1029/2004GL021750

Pockett S. Problems with theories that equate consciousness with information or information processing. Frontiers in Systems Neuroscience 2014, doi: 10.3389/fnsys.2014.00225

Pockett S, Whalen S., McPhail A.H. and Freeman W.J. Topography, independent component analysis and dipole source analysis of movement related potentials. Cognitive Neurodynamics 2007;1: 327-340. DOI 10.1007/s11571-007-9024-y

Pockett S, Bold GEJ and Freeman WJ. EEG synchrony during a perceptual-cognitive task: Widespread phase synchrony at all frequencies. Clinical Neurophysiology 2009;120: 695-708.

Roosevelt FD. https://www.presidency.ucsb.edu/documents/message-congress-curbing-monopolies, 1938.

Watson OJ, Barnsley G, Toor J, Hogan AB, Winskill P and Ghani AC. Global impact of the first year of COVID-19 vaccination: a mathematical modelling study. Lancet Infectious Diseases 2022; 22:1293-1302.

Wigner E. The unreasonable effectiveness of mathematics in the natural sciences. Communications in Pure and Applied Mathematics 1960;13(1).