3 TAKING PRECAUTIONS, BUILDING RESILIENCE

The focus of the sustainable economy is on the next generation, and that next generation can look after the one after them. Whether humans last another 10,000 years, or even 100,000 years; whether we go the way of all the other species, with extinction as our destiny; whether an asteroid hits, or a pandemic wipes us humans out; these are all interesting questions, but ones we do not need to answer. The geological record is littered with such calamities, punctuated by mass extinctions. There are lots of fossils, and ultimately that is probably our destiny too.

These potential catastrophes have got a lot nearer after the damage the twentieth century has wreaked on our environment. There might not be the luxury of waiting to find out whether these long-distant catastrophes happen. For most of human history, the answers to both the near- and far-term threats were thought to be in the hands of the gods. But increasingly humans think that they uniquely can avoid all these fates, and do so because of science, heading off asteroids and developing vaccines for viruses and antibiotics for bacteria, and fixing climate change by manipulating the atmosphere and biodiversity by genetically engineering life.

This 'masters of the universe' approach to our future depends upon the assumption that humans are benign, rational, and will cooperate to head off existential challenges. Such confidence gets quickly dented by the experiences of the twentieth century. In just a

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blip of time of human life on earth, and an indiscernible scratch on geological time, humans developed the capacities to destroy much of life on earth. Nuclear war could do the job very quickly, and for the second half of the twentieth century this was a very real possibility, casting its shadow of fear.[1] In 2022, Vladimir Putin put it back on the agenda again. So, too, could the escape of viruses from laboratories and biological warfare, raising the possibility of uncontrolled diseases and death, from anthrax to the twenty-first-century coronavirus.

These are all specific and very real threats, about which we can do a lot. The more general environmental damage is much more difficult, but at least this is no longer about ignorance of the causes or indeed the broad consequences. That much science has delivered to us. It is the inability to head off these very human-made threats to our existence that is the concern.

The Scale of Our Ignorance

If we were certain all these bad environmental things were going to happen, it would be about taking action, in the sure knowledge of the consequences of that action. But in most cases, it is less clear. Though we know a lot about the causes of climate change, we do not know what the precise global temperature increase will be by 2100. It might be limited to 2°C warming, or even 1.5°C. The increased concentration of greenhouse gases in the atmosphere means that we are already on a path towards 3°C, and it could be even higher. The range between a good and a bad outcome could be as much as 4°C.

We do not know how much biodiversity will be left by 2100. We do not know whether by then we will have wiped out half the species on the planet or stabilised biodiversity. Whilst we can at least measure the concentration of the greenhouse gases in the atmosphere, we do not even have an agreed measure of biodiversity and we do not even know how many species there are on the planet, partly because most biodiversity is beneath our feet.

[1] O.A. Westad (2017), *The Cold War*, London: Allen Lane. Thomas Schelling wrote that one of the most surprising things is that no major nuclear weapon has been used since Hiroshima. T.C. Schelling (2005), 'An Astonishing Sixty Years: The Legacy of Hiroshima', Prize Lecture, Department of Economics and School of Public Policy, University of Maryland, 8 December.

We do not know whether by 2100 the rivers and the coastal waters will be even more heavily polluted with yet more plastic, chemicals and agricultural run-off, or whether they will be cleaner and full of life. Will the seas be fished out and the sea floor scraped clean by trawlers, or will there be a recovery and vibrant marine ecosystems?

The pervasiveness of our ignorance is reinforced by our inability to forecast even a few years ahead. Economists' forecasts of GDP growth are notoriously inaccurate and there is no evidence that forecasting is getting better. Economists struggle to forecast a recession a few months in advance, and most did not see the financial crisis coming in 2007/8. It was not just the late Queen Elizabeth II in the UK who wondered why it had not been foreseen.[2] Forecasts of fossil-fuel prices are just as bad. Taking the projections of the International Energy Agency (IEA) since the 1970s, one study showed that at any point in this period it was better just to take the current price and extrapolate it, rather than to rely on the IEA's projections.[3] Up until 2014, the oil price was heading ever higher. Then it crashed. In 2022, there were lots of people certain it would carry on going ever upwards, and even more certain that the gas price would follow a rising trend. Possibly neither will.

Scarily, many are taken in by these sorts of forecasts and projections. Commentators hang on them, and behave as if they are true. The vogue in 2022 for believing that gas prices will go on upwards for the rest of the decade led opportunists to argue that, in these circumstances, all sorts of low-carbon technologies will be in the money. It reflected the pernicious influence of lobbying we will return to again and again, especially when it comes to systems and regulation. Wisely perhaps these same opportunists are not themselves completely fooled, for acting on such a forecast would be a powerful argument for the removal of many of the subsidies these technologies rely upon to keep afloat. Vested interests tend to take seriously only those forecasts that suit their purposes. They do not campaign to take away the subsidies upon which they depend.

It is not just the underlying trends that we are ignorant about; it is also the technologies. As soon as the timescale opens up beyond the next couple of decades into the second half of the century, our ignorance

[2] *Financial Times* (2008), 'Good Question, Ma'am', 14 November, www.ft.com/content/5b306600-b26d-11dd-bbc9-0000779fd18c.

[3] See D.R. Helm (2018), *Burn Out: The Endgame for Fossil Fuels*, updated edn, New Haven: Yale University Press, pp. 17–18.

about technologies starts to bite. If we knew what technologies would be around in 2100, we would already have invented them. A moment's reflection on the fact that the modern internet and the iPhone and laptop are all post-1990 tells us how profound technical change can be in just thirty years. Over a century, technologies can be transformational. Recent advances of quantum computing, AI, graphene and genome sequencing are already apparent, but we have less idea what precisely they mean for the prospects of the next generation. We don't know whether there will be negative unanticipated consequences, as there have been from DDT (the chemical compound Dichlorodiphenyltrichloroethane) and a host of chemicals spread over the land, and whether AI might unleash a whole new set of authoritarian controls and warfare.

To reinforce the critical nature of this uncertainty, and how the future usually turns out rather different to what we anticipate, consider a thought experiment. Think back to any date, and then think forward from that date five, ten and thirty years into the future. Five years ahead, there are always surprises. The coronavirus is the latest in a long line. Few foresaw the scale and destruction of the twentieth-century world wars. They were both widely anticipated to be 'over by Christmas'.[4] Few saw the fall of the Berlin Wall coming. The Soviet Union was thought to be a given.

As the time horizon opens up, science fiction takes over. That is another reason – beyond our limited impartiality discussed in the last chapter – for the single generational perspective. Many countries now have unilateral aims to be net zero by 2050, and the UK has added the aim, through a twenty-five-year environment plan, to leave the natural environment in a better state for the next generation.[5] Achieving these limited objectives would be a huge advance on where we are now. Thinking beyond a year is often a major political challenge. Hence the often-quoted remark by UK Prime Minister Harold Wilson in the 1960s: 'a week is a long time in politics'.

There are pretty immediate political uncertainties to frame what we do about the environment. Here are some things to ponder

[4] On the First World War, see C. Clark (2012), *The Sleepwalkers: How Europe Went to War in 1914*, London: Allen Lane.

[5] Defra and The Rt Hon Michael Gove MP (2018), 'A Green Future: Our 25 Year Plan to Improve the Environment', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/693158/25-year-environment-plan.pdf. This is now embedded in the 2021 Environment Act.

in the quest to be sustainable even over the limited horizon of the next thirty years. What will happen in Ukraine and Russia, after the Russian invasion and the Ukrainian fightback? The fall of the Berlin Wall thirty years ago set in motion the current disaster. Will China invade Taiwan? The fall of the nationalists and Mao's Communist victory in 1948 set in motion the current threat by China to finish the business with Taiwan. Will China, the US and Japan go to war seventy years later? From a consumption perspective, will China's economy double or triple in size by then, with all the consumption that will bring? Or will it stagnate like Japan's has done since 1989? Will India and Africa grow fast, replicating the Chinese experience of the last thirty years?

These are just some of the uncertainties we face over the next thirty years. They are things that worry the young about their futures. They are more than enough to try to get a handle on, and indeed, if we do not, there might not be much left for the subsequent generations. Beyond 2050, the fog of uncertainty is even greater. Would anyone in 1920 have forecast an extra 1 billion added to the world population by 1950, and just under 6 billion by 2000? Or that temperatures would keep rising, in contrast to the concern in the 1970s, when global cooling and another ice age was thought by some to be the big threat?[6]

Try another thought experiment. Write down what you think now the world in 2050 may be like. Write down what you think the share of fossil fuels in world energy will be, relative to the 80 per cent today. Write down what you think the world population will be. Write down the main wars that you think will have happened by then. Write down by how much you think GDP in, say, the UK, the US, India, China and Nigeria may have gone up or down. Write down what technologies you think will dominate by then: electric cars, hydrogen, how you think quantum computing will go, whether you will be using cryptocurrencies. Then seal the envelope and lock it away ready for you to open in 2050, or leave it in your will for your inheritors to read. I would be amazed if you or they are not surprised.

All this matters because we are doomed to work in this murky world of uncertainty. Indeed, it is what makes human life so interesting. When it comes to thinking through how the bold objectives to limit climate change and protect biodiversity are going to be met, and how

[6] The concern focused on orbital forcing, and the return of the ice age, within which the current period can appear to be embedded, and on the emissions of aerosols.

we are going to get back onto a sustainable growth path, we should always start with the realisation that the gap between what we assume will happen and what might actually happen is very wide. We look out of the back window at our past to steer the car, assuming the future will resemble that past. When we close our eyes to many of the uncertainties, and what might lie around the bends in the road in front of us, we condemn ourselves to the certainty that our mistakes will commit us to. We treat the future as determined by the past, rather than open-ended, created by the decisions we make on the basis of the possibilities in front of us and our imagination.

How to Decide in Uncertainty

What should we do? How should we tackle these profound and deep uncertainties to save our planet? There are two very different approaches. One is to treat these circumstances as approximations to certainties, and to do all the sorts of forecasting and predictions that find their way into government budget forecasts, the Federal Reserve's and the Bank of England's forecasts of inflation, and the IEA's oil projections. This is what modern economics excels at. The other is to start with the assumption of radical uncertainty and work back by providing some stakes in the ground, in particular taking measures to make sure that the natural capital and the core infrastructures are maintained.

Modern economics makes the heroic assumption that we act as if we have probabilities over all future possible outcomes, allowing us as rational individual consumers to choose between the sure prospect of utility now as against the (discounted) expected utility at some future date to maximise our subjected expected utility.[7] It allows economists to go straight to future utility, and not to waste too much time on the underlying architecture of the economy. This is what lies behind many of the economic forecasts and economists' policy recommendations. It allows the clever planner to shape the future. It is a world for experts.

It is always possible to straitjacket behaviour into a probabilistic structure. Choices can always be rationalised as consistent with

[7] For a survey, see P.J. Schoemaker (1982), 'The Expected Utility Model: Its Variants, Purposes, Evidence and Limitations', *Journal of Economic Literature*, 20(2), 529–63.

you having subjective probabilities.[8] But that does not mean you do. Faced with the uncertainty unfolding before us, a better description of your behaviours is that you use the toolkit of behavioural psychology, to help deal with the reasonably familiar. Each of us relies on simple heuristics, often translating them into a series of mantras, passed down the generations. They are usually historically conditioned. Victorians believed in thrift and the avoidance of debt; consumerist societies embrace the opposites. 'Neither a borrower nor a lender be' is a heuristic that would be incomprehensible to most of the current US and UK populations, and to Keynesians in particular.[9] But it would not be to Germans, who prefer 'save now, have later'. These are all part of the shared and inherited social capital.

Environmental conservation is littered with such heuristics. One is to be precautionary, especially where the environmental damage might turn out to be irreversible. None is 'optimal', but then the very concept of optimality is challenged by radical uncertainty.

Such heuristics can work roughly well, until we hit the unknown unknowns, what in economics is known as 'Knightian uncertainty',[10] with the negative shocks and possible but highly improbable 'black swans'.[11] In these contexts, there are no heuristics to fall back on, no rules of thumb, because there has not been enough time to try to understand what is going on. Extrapolating from what has worked in the past is potentially very dangerous, given that the past has brought us to the current environmental cliff edge.

It is sometimes argued that the financial crash in 2007/8 and the coronavirus in 2020 are just such black swans. They came out of the blue, and most people had no obvious mental framework to comprehend what was going on. They left us very disconcerted. In time, people got used to these events, read and understood more about them, and then developed new rules of thumb about what to do if they happen again: using heuristics like 'keep social distance', 'open windows', 'wear masks' and 'take Vitamin D'. In the financial crisis case, it might be to save more to create a precautionary buffer, and in the virus case,

[8] See L.J. Savage (1951), 'The Theory of Statistical Decision', *Journal of the American Statistical Association*, 46(253), 55–67.

[9] In Act I, Scene III of *Hamlet*, William Shakespeare has Polonius saying 'Neither a borrower nor a lender be; / For loan oft loses both itself and friend.'

[10] After F.H. Knight (1921), *Risk, Uncertainty and Profit*, Boston: Houghton Mifflin.

[11] N.N. Taleb (2007), *The Black Swan: The Impact of the Highly Improbable*, London: Allen Lane.

to stockpile essential items. For climate change and biodiversity loss, it makes sense to do the capital maintenance, to build environmental resilience. Sadly, there is not much evidence that many of these heuristics are much more than passing enthusiasms. The next financial crisis will probably see us as exposed as last time around. On future viruses, public health measures taken now look precarious, and on climate change and biodiversity loss, so far little has been done.

Resilience

The curious and potentially dangerous feature of reactions to these sorts of possible shocks is that since we have no underlying deep causal explanations – since they are shocks – the most likely behaviour is indeed to carry on as before. The implication is that the greater the uncertainty, the more predictable our behaviour. Applied to climate change and biodiversity loss, this would be disastrous, yet it is a pretty accurate description of what has been going on for the past thirty years. Only as more information becomes available, and we are able to frame the events with a causal theory, do we adapt and change, but crucially *after* the shocks and in response to them, not in anticipation. Even when we do know more, we go on with our existing consumerist ways in a kind of parallel world, doing the same as yesterday even though we know it is not sustainable. Recall, the share of fossil fuels in the global energy mix remains at 80 per cent, the same as it was in 1970.

In the face of possible future shocks, we are not powerless to prepare, even if we do not know the format they will take or when they might appear and we do not have probabilities. In the two examples above, financial shocks do happen, and by studying past events, we can identify the main features. It is a bit like watching pre-earthquake tremors ahead of a volcanic eruption. Similarly, there have been lots of pandemics, and some of the consequences are known. Pandemics are part of the human condition. Climate change has happened quite a lot even in human times, and there have been great extinctions in geological history. Financial shocks, pandemics and climate change are all in this sense normal.

In these cases, the right response is to have the assets in place to cope as and when the shocks happen. It is about having the *capacity* to cope, about being *resilient*. The social care system could be capable of handling isolation caused by the pandemic lockdowns, and have

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had testing facilities. There could have been reserves to deal with the fallout from the credit crunch. It is not the uncertainty that is necessarily the problem, but rather having the assets capable of absorbing shocks. *Resilience*, not expected utility based upon probabilities, is the key requirement, so that future people are not left defenceless.

Take climate change. We have integrated assessment models (IAMs)[12] based upon probabilities, and hosts of energy models, and over time these are updated as new information becomes available. We have a schedule of costs for alternative low-carbon options, comprising a supply curve. Optimising the solution to climate change is, in these conventional models, about choosing the cheapest of these options against the damage that climate change is expected (probabilistically) to cause. Economists make the expected marginal costs equal to the expected marginal damages, and then come up with a social cost of carbon. Probabilities of marginal costs and marginal damages are then discounted back to the present. The expected utility approach simply multiplies the probabilities and the utilities together. This tells us how to go about tackling climate change.[13]

Except that this is not what we are actually doing and for good reasons. The 2°C target has no foundation in this sort of marginal analysis.[14] It is picked not because it is 'optimum' in an expected utility way, but because it is a rough guess at what we might aspire to achieve. We pick a target and then work back to thinking through how we might achieve it. We decide what it would be tolerable for the next generation to inherit, and what we might actually be able to achieve

[12] See DeCanio for what is still one of the best critiques of IAMs. S.J. DeCanio (2003), *Economic Models of Climate Change: A Critique*, London: Palgrave Macmillan. For a further discussion, see W. Nordhaus (2019), 'Climate Change: The Ultimate Challenge for Economics', *American Economic Review*, 109(6), 1991–2014.

[13] It is how, for example, Stern's critics, Nordhaus and Weitzman, go about it. W. Nordhaus (2007), 'A Review of the Stern Review on the Economics of Climate Change', *Journal of Economic Literature*, 45(3), 686–702; M.L. Weitzman (2007), 'A Review of the Stern Review on the Economics of Climate Change', *Journal of Economic Literature*, 45(3), 703–24.

[14] Various economists have tried to work out what the optimal degree of global warming might be. Of these, Nordhaus is perhaps the most prominent. In 2018, he suggested unabated climate change would reach 4°C warming, and compounded this with 3.5°C which would result from an optimal carbon tax. W. Nordhaus (2018), 'Projections and Uncertainties about Climate Change in an Era of Minimal Climate Policies', *American Economic Journal: Economic Policy*, 10(3), 333–60. See also K. Rennert, B.C. Prest, W.A. Pizer et al. (2021), 'The Social Cost of Carbon: Advances in Long-Term Probabilistic Projections of Population, GDP, Emissions, and Discount Rates', *Brookings Papers on Economic Activity*, BPEA Conference Drafts, 9 September.

for them, not how to optimise the expected utilities through time, and hence get the maximum happiness. Similarly, in working out how to tackle the coronavirus, we did not start with the expected utility and the life expectancy of people who might die, and compare the expected economic utility value of those lives that might be lost against the costs of saving them.[15]

The reason we do this is not just because we do not know the probabilities and the utilities of future people. That sort of climate change calculation cannot be made in any meaningful way. It is partly because we are uncertain about what the technologies are going to be even over the limited time horizon to 2050. Whether hydrogen will prove a key technology, whether there will be new forms of nuclear power, whether a new type of solar film becomes available, are all uncertain. So too is the effectiveness of future vaccines and antibiotics. None of these is amenable to probabilities. What we do know is that if future generations are to be able to live good lives, it is a good working assumption that they will need a climate that is no hotter than the 2°C target, and they will need a lot of biodiversity and protection against horrible viruses and bacteria, to give them some sort of resilience to these sorts of shocks. It is just conceivable that they might not need the resilience these things bring, but not remotely likely. The open-ended choices that make up the good life and conspire together to write the future history of our life on earth are more than the sum of expected subjective utilities.[16] There is so much more to life than economists assume. We should start the other way round to the conventional economists' approach: by defining the set of assets necessary for the sustainable economy, make sure they are resilient and then leave open how people choose to live their lives, safe in the knowledge that they will have inherited a world in which they can in fact do so.

The sustainable economy is one that starts with this polar opposite to the economists' models. It assumes that we are profoundly ignorant about the lives of future people and the environment they will inherit. That is why the focus is on assets to facilitate options and

[15] Some economists did: for example, R. Rowthorn and J. Maciejowski (2020), 'A Cost–Benefit Analysis of the Covid-19 Disease', *Oxford Review of Economic Policy*, 36(S1), S38–S55; and D.K. Miles, M. Stedman and A.H. Heald (2021), 'Stay at Home, Protect the National Health Service, Save Lives: A Cost Benefit Analysis of the Lockdown in the United Kingdom', *International Journal of Clinical Practice*, 75(3).

[16] In the coronavirus case, we did not know in early 2020 whether vaccines would work. Amazingly, we did not even know how badly testing and track-and-trace would work.

opportunities, rather than on trying to make future people happy in the utilitarian way. The added twist – the working heuristic – is to be precautionary about the fundamental systems that drive the economy, and the renewable natural capital in particular. Nature gives us natural capital for free, but we can so easily close it off from future generations by our destructive ways. Once gone, that will be it forever. The sustainable economy is parsimonious and risk-averse when it comes to assets, and especially natural ones. Precaution breeds resilience.

Asymmetric Risks

How much risk should we take with nature? Resilience and precaution are not free. They have costs. The key question is not whether we want to be resilient to future environmental and other shocks, but *how resilient*. What if we are wrong? What if temperatures level out, or even stabilise at a higher level, where there will be winners and losers? What if the costs of mitigation are too great on the current generation, and the future generations are just that much better off? What if there are new technologies that deal with the problems and at much lower cost? What if we can genetically engineer life in the future? For some, it is quite possible to accept conventional theories of climate change and at the same time argue that the urgency of action is overstated. They just assume it will all turn out fine, in the best of all possible worlds, as Candide did in Voltaire's famous satire.[17]

The 1992 Rio Declaration on Environment and Development takes a different stance: 'where there are threats of serious or irreversible damage, lack of scientific certainty should not be used as a reason for postponing cost-effective measures to prevent environmental degradation'.[18] This 'precautionary principle' is one of two secondary principles central to the sustainable economy, and relies upon the claim that there is *asymmetric risk*: be too cautious and there will be costs; be not cautious enough and the losses will plausibly be much greater.

Asymmetric risk is familiar in the development of modern medicines. Tests and trials and a demonstration that there will be no harm are required before permitting general use of a new drug. Even

[17] F.-M.A. Voltaire (1759), *Candide, ou L'Optimisme*.
[18] United Nations General Assembly (1992), 'Report of the United Nations Conference on Environment and Development', Annex I Rio Declaration on Environment and Development, Principle 15.

with the coronavirus vaccines, trials were required. That's why it took several months to get from the quick few days taken to develop vaccines to the authorisation of their deployment. In practice, the vaccine trials were rushed as the pandemic started spreading and people started dying. The goalposts were shifted a bit. The reality of precaution is that the decision to adopt vaccines is subject to a 'beyond reasonable doubt' test, and weighs up the importance of speed in saving lives against possible side effects.

In the case of genetic techniques, a similar precautionary approach is taken. Many countries have banned genetically modified organisms (GMOs) and, in the case of the EU, severely limited gene editing. Those campaigning in the UK for BREXIT regarded this last restriction on gene editing as a precaution too far, and saw BREXIT as a way of relaxing this constraint.

In the case of the natural environment, there is a class of assets that demand precaution because the consequences of a mistake can be irreversible, and hence the asymmetries are large. The 'cost-effective' caveat is very unlikely to be binding. These are renewable natural capital assets, the things that nature gives us for free, and which can go on reproducing themselves for ever, or until evolution catches up with them. Make a mistake, take a renewable natural capital asset, say a species, below the threshold above which it can reproduce and sustain its population, then all the benefits of the species to us and the ecosystems are gone *forever*. Extinctions are to be avoided for exactly this reason. We should take a very precautionary approach to the loss of biodiversity, especially where otherwise we are taking temporary gains for the current generation at the expense of *all* future generations. The current generation occupies the crease (in the cricketing analogy), but presides over the benefits to all that come after it.

In the case of the climate, it is less straightforward. It might be possible at some future date to geo-engineer the climate so that its composition can be altered. The damage may be partially reversible (already there are direct air capture technologies to extract carbon from the atmosphere), but it might not be entirely so. The climate might be tipped into a new equilibrium or into a vortex of ever-higher temperatures. The atmosphere might be lost, analogous to the way Mars lost its water.

Given the asymmetry between the costs of mitigating climate change now, and the open-ended destructive losses of these possible

(and some would say even plausible) scenarios,[19] the precautionary principle tells us what to do. Time should not be wasted with the economists' cost–benefit analysis and the IAMs discussed above, but rather we should cut to the precautionary principle imperative, treat the atmosphere as a renewable natural capital asset and hold the line as best we can. Indeed, so important is this precautionary principle that it merits consideration of ways of embedding it constitutionally.

The question of whether 2°C is the right answer is at best an academic one, and one about which there is profound uncertainty. There is not the data to know the answer. The optimal climate cannot be defined. The precautionary principle tells us to try to keep below 2°C, just as it tells us to avoid extinctions and maintain the core ecosystems.

Austrian Economics and Entrepreneurs

Armed with the precautionary principle, and its imperative to maintain renewable natural capital, it is an obvious step to try to put in place detailed plans to achieve this. But again we should be aware of our ignorance and resist the temptation to assume that we know how the future will pan out. Scientists and economists too often just assume they know the answers or understate the uncertainties, and tell us precisely what we should do to head off climate change and biodiversity loss. They tell us how many wind farms should be built, how many nuclear plants and how fast the fossil-fuel industries should be closed down.

Detailed plans, ten point plans, carbon budget plans and specific technology 'winners' are identified and then governments design subsidies, regulations, standards and institutions to impose them.[20] This is both seductive and dangerous. Our ignorance dictates otherwise. Ignorance is not abolished by pretending that we can accurately model future paths of technologies and investments. Such certainty about planning also creates a further downside: it is manna from heaven for all those lobbyists and vested interests who can capture

[19] There is a considerable literature on tipping points. See, for example, T.M. Lenton, J. Rockström, O. Gaffney, S. Rahmstorf, K. Richardson, W. Steffen and H.J. Schellnhuber (2019), 'Climate Tipping Points – Too Risky to Bet Against', *Nature*, 27 November, www.nature.com/articles/d41586-019-03595-0.

[20] The most inane of these is the UK's 'ten point plan', which boils action down to ten points. HM Government (2020), 'The Ten Point Plan for a Green Industrial Revolution', November.

the plans and their implementations, and the subsidies that so often go with them. The net zero strategies are littered with such capture. Worse, many are not working and some are counterproductive.

The nature and role of planning is a fraught topic, often debated by pro- and anti- camps, without regard to the subtleties of the different dimensions of planning, and it is a topic that recurs throughout considerations of the sustainable economy, its regulation and institutions. It is not just about scientific ignorance; it is about the way incentives work to get to the answers. This is where the Austrian school of economics comes in, largely ignored by conventional economists.[21] The Austrians start in the right place with radical uncertainty. It is not just that people have limited information; it is that this is all they can have to take decisions and create the future. It is about pushing out the boundaries of the ideas and the technologies people create, the primary source of economic growth. This is what is going on in the numerous start-ups around new climate change technologies. One new silver bullet after another is proposed: nuclear fusion, new types of batteries, new solar films. Each tries to capture governments but each is better tested in the climate change marketplace.

Hayek, the central figure in the Austrian school, argued that in order to get the best out of people, there needs to be a competitive market. This is not the perfect competition at the heart of the conventional economic theories; in perfect competition, Hayek pointed out that competition is dead, because the future is known and there are only normal profits, leaving no incentive for market entry or exit.[22] For Hayek and the Austrians, it is the *possibility* of profits that drives entrepreneurs, and the competitive market sorts out the successes and failures.[23] Markets are in Joseph Schumpeter's words 'a process

[21] The Austrian school is the name given to an eclectic group of mainly economists who emerged out of the broader Vienna Circle. The key figure was Ludvik von Mises. See L. von Mises (1949), *Human Action: A Treatise on Economics*, London: William Hodge. Hayek and Popper provided the main philosophical and political underpinnings, with Hayek developing its economics as well. Frank Knight and Joseph Schumpeter variously promoted some of the main ideas, and many were taken up by the Chicago school of economics, and more recently, in the policy context, Stephen Littlechild, the architect of RPI-X regulation and a powerful advocate of privatisation and competition in the UK, translated some of the key insights into practical policies.

[22] F.A. von Hayek (1948), 'The Meaning of Competition', in *Individualism and Social Order*, Cambridge: Cambridge University Press.

[23] See chapter 30 in G.L.S. Shackle (1969), *Decision Order and Time in Human Affairs*, 2nd edn, Cambridge: Cambridge University Press, and (1972), *Epistemics and Economics*, Cambridge: Cambridge University Press.

of industrial mutation that continuously revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one'. The possibility of profits lures in rivals, and their ideas and innovations are tried out in the hard reality of competitive markets.[24] Economic evolution follows a path of market selection.[25] Right now new hydrogen technologies are being tried out and will have to compete with alternative ways to decarbonise unless, of course, they are permanently protected by subsidies.

The point about this Austrian competitive process is that the future cannot be defined in probabilistic terms. It is radical Knightian uncertainty that makes the case for markets and competition. Scientists, intellectuals and business entrepreneurs advance knowledge, making the future up as they go along, on the basis of conjectures and their refutations, to use Karl Popper's terms.[26] They scan the possibilities, and then use their imagination to make decisions across a range of possible future scenarios. All knowledge is tentative, and the way to build it up is to try to knock down the conventional wisdoms. Many entrepreneurs and innovators are fixated with particular possibilities, often displaying beliefs that go well beyond the rational. This is the world of Elon Musk, Bill Gates and Jeff Bezos, and the inventors of innumerable new digital businesses. All are flawed, all take big risks and most fail. Many are led by highly egoistic, dyslexic and irrationally optimistic individuals. For new ideas and inventions, there are no probabilities, because they do not exist until they are created.

Open Societies

The sustainable economy creates the space, through assets, to encourage trying out the conjectures, so that the new technologies can unfold. It puts entrepreneurs, researchers, mavericks and eccentrics centre stage in finding practical solutions to climate change and biodiversity loss.

[24] J. Schumpeter (1942), *Capitalism, Socialism, and Democracy*, New York: Harper & Bros. It is very much borrowed from Karl Marx. See K. Marx (1951),*Theories of Surplus Value: A Selection from the Volumes Published between 1905 and 1910 as 'Theorien über den Mehrwert'*, ed. K. Kautsky, taken from Karl Marx's preliminary manuscript for the projected fourth volume of *Das Kapital*, translated from the German by G.A. Bonner and E. Burns, London: Lawrence & Wishart.

[25] R.R. Nelson and S.G. Winters (1982), *An Evolutionary Theory of Economic Change*, Cambridge, MA: Belknap Press.

[26] K. Popper (1963), *Conjectures and Refutations: The Growth of Scientific Knowledge*, London: Routledge & Kegan Paul.

The Austrian approach to competition and markets, and to capitalism more generally, has always had a political economy underpinning. Popper was interested in creating a society (and a supporting economy, though he did not much interest himself in economics) in which this critical process of attempted refutation would have maximum scope, and where individuals could keep throwing up bold conjectures to be knocked down. The sort of society he had in mind was an open one, and one free of determinism and certainty.[27] Piecemeal corrective measures to market failures could fall into a trend – a slippery-slope argument.

The Problem with Planning

Hayek and the Austrians have a further insight which helps to explain why the many policies and interventions in support of detailed plans and picking winners will fail, and indeed have done so far, given how little progress there has been to stop the increase of carbon in the atmosphere over the last thirty years or to halt biodiversity loss. Hayek generally prefers competitive markets to state planning because the planners do not really know what they are doing. They think they do and, certain of their knowledge, they try to 'nudge' us towards what they think is in our best interests and even evoke the dark arts of behavioural economics to help to get us to do what they want. But they don't know. Planners have to put themselves in our shoes, know all the underlying preferences and motivations of the consumers, and all the production costs, and all the (exogenous) technologies, now and into the future by knowing the probabilities too, to pick the 'right' allocation of resources.[28]

[27] K. Popper (1945), *The Open Society and Its Enemies*, 4th revised edn, 1962, London: Routledge & Kegan Paul. He accused them of 'historicism', and with Hayek's *Road to Serfdom*, the two books set out not only the critique of Marxism and the Soviet variant in particular at a time when many of the intellectuals in the West were being seduced by both, but more generally Popper and Hayek claimed that state planning was a stepping-stone towards these more totalitarian forms of government. Social democracy and welfare states were the slippery slopes to 'serfdom'. F.A. von Hayek (1944), *The Road to Serfdom*, Chicago: University of Chicago Press. See also G. Orwell (1944), 'George Orwell's Review of Hayek's The Road to Serfdom', in G. Orwell (1988), *The Complete Works of George Orwell*, vol. XVI: *I Have Tried to Tell the Truth 1943–44*, London: Secker and Warburg.

[28] See F.A. von Hayek (1948), *Individualism and Economic Order*, Chicago: University of Chicago Press.

This is the sort of thinking that lies at the heart of great plans for tackling climate change, with a certainty that is often staggering. Past energy strategies, energy plans, specific technology supports and a remarkable number of speeches that purport to provide us with a silver bullet are littered with this sort of thinking. The UK's Climate Change Committee (CCC) produces five-year carbon budgets, and sets out, technology by technology, the route to the 2050 targets. There are elements of Soviet-era 'tractor plans' here.

For this to work, government ministers have to be very clever, and avoid capture by vested interests and corruption. They need to be sceptical and have doubts, rather than the sorts of naive certainties many politicians echo. Even where well-intentioned, the track record is often appalling, before we add in such capture.[29] Whereas the markets punish the mistakes of businesses, the state faces only weak sanctions, if any at all. Think of the UK example of Boris Johnson and his garden bridge, bendy buses, the bridge to Northern Ireland, faith in 'sustainable' aviation fuel and his 'ten point plan'. Think of all the jobs in these vested interests that ministers and their advisers take up upon leaving office or even come from. It is no wonder that the path to the sustainable economy remains elusive. It is elusive by design. This ever-present risk of capture and the distortions caused by lobbying is a cancer at the heart of attempts to tackle the great environmental problems of our time and to get to the sustainable economy.

In Hayek's world, the beauty of the competitive market is that each of us only needs to know the current prices and have the liberty to choose and experiment. It is a stark warning against making the jump from the recognition that we face existential challenges in climate change and biodiversity to the assumption that the state (or the CCC in the UK case) knows best and that, if only we can move to state planning, all will be well. Experts can fix climate change if only stupid politicians and us the voters would pay attention. The lazy and easy jump from recognising the environmental challenges to state planning turns out to be, if not Hayek's *Road to Serfdom*, at least a hazardous and often very costly approach.

A Hayekian economy is one with a constitution of liberty, keeping the competitive markets open.[30] The economy of conventional

[29] See D. Helm (2006), 'Regulatory Reform, Capture, and the Regulatory Burden', *Oxford Review of Economic Policy*, 22(2), 169–85.

[30] F.A. von Hayek (1960), *The Constitution of Liberty*, Chicago: University of Chicago Press.

economists tries to pick the equilibrium path on the basis of assumed exogenous preferences, probabilities and exogenous technologies. This Austrian openness in the presence of fundamental uncertainty constrains the role of the state because it recognises that not only are market participants ignorant about the future, so too are governments.

What Hayek (and many neoliberals who have followed his lead) understates is the need to ensure that the assets – the core infrastructures – are in place to set the *context* within which the choices are made, and the need for the state to force polluters to face up to the costs of their pollution: the polluter pays (a key secondary principle of the sustainable economy). It is the difference between the negative liberalism of John Stuart Mill, and the positive liberal approach of Isaiah Berlin and Amartya Sen we met in chapter 2. *Some* planning and *some* state provisions are essential, and they will turn out to be quite a lot bigger than Hayek had in mind. It will also turn out to be essential for competitive markets to work as Hayek wants them to. Markets and *system* planning (and support for R&D) turn out to be complements, not substitutes. It is not a simple choice between planning or competitive markets, but rather about what kind of planning is essential for the sustainable economy and its markets to prosper.

Technical Progress and the Sustainable Economy

Technical progress has a starring role in the sustainable economy. There is no plausible explanation for why and how technical advance actually takes place. This is another of the great insights of the Austrians, who put innovation and specific technological progress as central to the way they think about the architecture of an economy, full of individuals free to create history, and, with it, creatively destroy what went before, to make bold conjectures and then face the music of their refutations. But what the Austrians neglect is that they do this within the framework of both support for science and state provision of many of the great system public goods. The problem with R&D and innovation is that ideas once discovered are public goods, and private markets have a big incentive problem with public goods. They are not rivals – we can all benefit simultaneously, and it is hard to exclude people from their benefits. Entrepreneurs cannot capture all the profits, nor should they. We can – and should – benefit from Darwin's theory of evolution. They need public support and patents

to create private property rights. It is the market *and* the state, not the market *or* the state.

Technical progress of the sort needed in the sustainable economy to address climate change and biodiversity loss rests upon *fundamental* research, and this tends to be done by universities and research laboratories supported by the state. Private charities and rich individuals may contribute, but altruism is unlikely to be even remotely adequate. These research institutions are core assets necessary for the sustainable economy to have the capability to innovate. They are an essential part of building in resilience to unknown unknowns that may cause shocks to future people. Fundamental climate science relies on fundamental physics, and fundamental genetics research helps us to understand how to protect biodiversity.

The Austrian economists are right about the dangers of direct state support for a specific technology and the legions of lobbyists that lie behind each one. But they go too far. The core infrastructure assets, and natural capital in particular, will not spontaneously be created and maintained. The generational ethic, the key principle of the sustainable economy, will not be met solely by reliance on competitive markets. Whilst Hayek is neither a conservative nor a *laissez-faire* economist, and recognises the need for a constitution of liberty, and hence a state, and he does mention public goods, he does not put these infrastructures at the core of his ideal economy. This is where he and I part company. In many infrastructures, as systems, there is no choice but to do some planning for all the faults that Hayek identified. The question is about what sort of planning is appropriate.

In the sustainable economy there would be lots of fundamental research. This is not only further from the market, but open-ended. All sorts of research projects have no obvious use and application – until one turns up. Einstein's theory of relativity transformed science, and this has fed into lots of things we now consume and take for granted. Darwin's theory of evolution is the foundation for modern genetics; quantum physics may deliver quantum computing. Our modern world is defined by the unexpected results of such fundamental research.

The sustainable economy would allow for lots of potentially wasteful R&D. It might bring us new materials for capturing solar power, new ways of using nuclear power, new materials for building and new ways of capturing carbon. It might also bring new ways of protecting the genetic variety of plants and animals,

and new understanding of how ecosystems work, and their capacity to sequestrate carbon. Or it might not. Mostly it will fail. The key point is that a scientific research basis is a critical part of resilience in the face of fundamental uncertainty.

The Sustainable Economy Based upon Uncertainty

To sum up. The Austrians have the right idea: start with an assumption of radical uncertainty and then work out how best to organise the economy and the wider open society to embed trial and error, human ingenuity and entrepreneurial forces. Forget about probabilities and exogenous and given preferences, exogenous technical progress and rational consumers maximising utility. Allow the Amazons, Apples, Microsofts, Googles and Facebooks to innovate and have their products and services tested in the markets, even if the subsequent monopolies need breaking up and regulating. The planners have the wrong idea when they start with the assumption that governments and their committees and advisers are better than markets, replace competition with the state picking the winners and try to nudge and persuade us that they are right. Typically it is losers who pick governments.

We need to be clear about what we don't know. We don't know what future people's preferences will be. We don't know what technologies they will have. We don't know what their options would be if they were deprived of primary assets, such as natural capital. We don't know what would make them happy, even if we wanted to make them happy. Ignorance is the pervasive context of human endeavour, and it is what makes life interesting. A perfectly competitive general equilibrium is not only one where, as Hayek rightly pointed out, competition is dead, but it is also profoundly boring. It is not the human condition.

What we can do is provide future people with the capabilities within which to make their choices. To do this we want to transfer to them lots of ideas and technological opportunities, and we want to have an economic system that promotes and encourages that technological advance. We also want to make sure they have the infrastructure systems within which to function.

The main foundation to face uncertainty is the set of sufficiently well-maintained primary assets, and then citizens can better accommodate the shocks that may come. This is about resilience,

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notably in the face of asymmetric risks. It is hard to think of any shock that is unforeseeable *in general*. Tsunamis, pandemics, asteroids, sudden methane escapes from the tundra, volcanoes, severe weather – these would all be shocks, but they are also shocks we could prepare for. In each case, having the resilience that the primary assets provide in place and properly maintained is a good starting point. We do not know with any precision what will confront the next generation, but we can enable future people to better cope by ensuring that they have the assets so that they have the capabilities to respond. The sustainable economy has a good chance of sustaining itself in the face of the known unknowns, and most of the unknown unknowns are in fact known in outline. Donald Rumsfeld's famous triad should be rewritten: knowns, known unknowns and known shocks.[31]

Uncertainty is pervasive, fundamental and it requires that the sustainable economy is designed around it. Assets are the essential building blocks, to which we now turn.

[31] D. Rumsfeld (2002), US Department of Defence news briefing, 12 February.