CHAPTER 1

Introduction

Or, Do We Really *Need Another Book on Climate Change?*

The time is out of joint – O curséd spite,
That ever I was born to set it right!

—W. Shakespeare, *Hamlet, I, 5, 188–190*

If a man writes clearly enough anyone can see if he fakes.

—E. Hemingway, *Death in the Afternoon, Chapter 5*

In the run-up to the 1929 market crash financier Joe Kennedy remarked that, when you hear a stock tip from a shoeshine boy, it is time to get out of the market. Similarly, when you notice that the racks of your average airport newsvendor seem to hold more books about climate change than crime thrillers, it is fair to conclude that the market for climate-change books is truly saturated. Yet, I believe that there is room on the rack for one more book. This one. What makes me think so?

There is great uncertainty about the magnitude of the threat posed by climate change, with 'respectable' projections of climate outcomes ranging from the severe-but-manageable to the catastrophic. When many commentators routinely refer to global warming as a climate emergency, yet Yale Prof Nordhaus, an economics Nobel-Prize winner for his pioneering work on the modelling of climate change, recommends that our resources are best spent today on climate research, rather than on hasty and costly abatement, the intelligent reader to whom this book is addressed is understandably perplexed. How has this state of affairs arisen?

Partly this is because, while the science of climate change is reasonably settled, its economics and ethics appear to inhabit the land of 'anything

goes'. In these 'relativistic' times, this seems to suggest to some that also when it comes to climate change we can interpret the evidence at hand to reach whichever conclusions we want. At the opposite end of the intellectual spectrum, the way the climate-change problem is often framed seems to imply that 'the facts' uniquely determine what we should do. Don't get me wrong: facts *are* extremely important, because they determine what is achievable, and what our real choices are. But facts do not determine ethical choices, and these play a key role in deciding what we should do to curb climate change. Providing facts is the job of scientists. Making ethical choices is the job of open-minded, inquisitive and intellectually honest citizens. The goal of this book is therefore to provide this open-minded, inquisitive and intellectually honest reader, not only with the key facts, but also with a mental compass to navigate the uncertain waters of the climate debate.

As she proceeds through the book, the reader will become progressively aware that making thoughtful decisions about climate change is no easy task. Faced with the attending choices, humans are today forced to make choices whose consequences could end up being farther-reaching than any of the decisions they have had to make in their history, as their actions can affect the outcomes not just for this or that group of people, but for humanity a whole.[1] We may even find it unfair that the responsibility for fixing a situation that, unbeknownst to us, had been getting progressively more serious since the start of the Industrial Revolution, should fall so heavily on our shoulders. Like Hamlet in the quote that opens this chapter, we may feel not just that time is out of joint, but also that it is a curséd spite that setting it right should be up to us. However, it *is* this generation that must make some of the key choices about what to do about climate change: again as in Hamlet's case, no choice is painless, and no choice is easy. But since Hamlet's reluctance to act ended in tragedy, this is where I would like the parallel with his predicament to end. It is exactly because the task is so daunting, and the temptation to do nothing so strong, that with this work I intend to give the reader some tools to make the task more manageable. And, inspired

[1] Searching in my mind for another such example, I can only think of the development of nuclear weapons.

by the quote by Hemingway that opens this chapter, I have tried to do so using the simplest and plainest language to convey ideas from a technical and specialized field. I have strived to do so because clarity, I strongly believe, is a necessary condition for honesty – whether I succeeded, of course, is an altogether different matter.

Let me manage, not only the reader's, but also my own expectations right from the start. If you are totally convinced that we are living a climate emergency, and that this is our last chance to avert an 'existential threat', you may well ask why we need to *write* more about the subject. Surely, if we are teetering along the edge of a climate precipice, it is now time for action, not for analysis. The only books we need now are 'activist pamphlets', written in the trenches of climate warfare, not the one you are reading. At the opposite end of the ideological spectrum, if you believe that the threat from climate change is an outright 'hoax', or that it has been blown out of all reasonable proportions for political and ideological motives, you will probably conclude that my book is not a dispassionate examination of the climate problem, but a thinly disguised ploy in the climate-change conspiracy. Much as I would like to, I doubt that I will be able to change the minds either of the climate-change deniers, or of the catastrophists-who-entertain-no-doubts. But, I hope, there is a large middle ground of genuinely concerned and perplexed citizens who would like to form a balanced view, based on facts and on clearly identifiable moral choices. This is the readership I strive to reach.

Does my readership really need convincing that swift and large-scale climate action is needed? If we leave to one side Hilary Clinton's 'deplorables' – whose mind probably cannot be changed anyway – aren't we all convinced of the reality and urgency of the climate problem by now? Yes and no. A perplexing narrative has recently gained wide currency, according to which it is the politicians who are dragging their feet, and stubbornly ignoring what 'the people' want: I am sure that Greta Thunberg's 2019 'How dare you' speech at the UN climate summit still resonates in my readers' ears, and the target of her tirade were, of course, the politicians gathered at the summit. Now, to paraphrase Warren Buffet, in the last decade or so politicians worldwide seem to have been hell-bent on discovering new ways to make themselves distrusted, when the old ones were working so well. However, if we exclude China

and Russia, in the highest-emitting countries the politicians whose responsibility it is to enact measures to curb climate change are put in power by their electorates. Now, at the time of this writing the grand total of Green party representatives in the UK, France and Italy combined is one. Admittedly, in the 2021 elections the German Green party did much better than in the past, but even in its *annus mirabilis* its vote tally only added up to 15 per cent. Voters seem to like the idea of going green, but, when faced with job losses in coal mining communities, increases in fuel tax, restrictions on short-haul flight, or withdrawal of fossil fuel subsidies, they do not cast their votes for the parties that ask for real sacrifices: they vote, if at all, for those who promise big climate changes with little or no pain (planting trees is one of the favourite get-out-jail cards – not surprisingly, the Trump administration, not known for its unwavering commitment to fighting climate change, was a whole-hearted supporter of the Trillion Tree Initiative).[2] Yes, fossil fuel lobbies *are* powerful, but what stops politicians from taking decisive (and painful) climate action is not the fact that they are in the pocket of the oil lobbies, but that, when they present the electorate with unpalatable, if necessary, choices, they are routinely not elected. So, voters (in Europe at least – in the US the situation is far more complex[3]) do not need convincing *in the abstract* that we must act to curb climate change and that there isn't too much time to waste. However, they have been convinced, or have convinced themselves, that the transition can be painless, and the changes in our ways of living can be, if not cosmetic, certainly easily manageable. As I am not a politician, and therefore I do not have to run for re-election,

[2] US Department of the Interior, 13 October 2020, *Trump Administration Furthers Commitment to One Trillion Trees Initiative*. For a brief discussion of the Trillion Tree Initiative, see Chapter 15.

[3] Opinion polls conducted by the reputable Pew Research Centre in 2019 found that 49 per cent of conservative Republicans, who represent the party majority, believe that fossil fuel production must be *expanded*. And only about half of Americans believe that 'human activity contributes a great deal to climate change'. Twenty per cent of all Americans believe that the human action has a negligible impact on the climate (45 per cent when we look at Republicans), and 35 per cent that the main causes of global warming are 'natural'. See, www.pewresearch.org/science/2019/11/25/u-s-public-views-on-climate-and-energy/.

I intend with this book to change the minds of my readers on this important point, and to convince them not only that the changes ahead are indeed urgently needed, but also that they will have to be deeply upsetting.

How do I plan to achieve this ambitious task? First, I intend to convince my intended reader that, for once, the way economists think about the climate-change problem is both insightful and helpful – and, as an extra bonus, intellectually rewarding. But my contention is stronger. I want to convince the reader that looking at climate change through the lens of economic analysis doesn't just provide an alternative interesting vantage point. I want to argue that we cannot make sense of the abatement choices ahead of us if we ignore what economics has to say about three absolutely fundamental aspects of the climate-change problem: scarcity, externalities and strategic interactions. It is no exaggeration to say that we would not have a climate *problem* in the first place were it nor for scarcity; that the problem has arisen because of a massive-scale market failure (this is the externality bit); and that finding a solution is so difficult because of the free-rider problem (and this is where strategic interactions come to the fore). Dealing with these three features is part of the job description of any economist (but of no other scientist), and the discipline of economics has accumulated over decades valuable insights about how to handle them. Economists, of course, are far from holding all the answers. However, without looking at the problem from an economics perspective none of the answers we come up with is likely to make much sense. This is why I believe that understanding how economists conceptualize the climate-change problem – reductive as their approach may be – is indispensable if my 'model reader' wants to reach her own conclusions on the topic.

1.1 WHAT CAN ECONOMICS OFFER?

Convincing my reader that examining the problem of climate change from the perspective of economics is going to be not just rewarding, but actually necessary, is not an easy sell. Economists do not command the same trust or inspire the same confidence that 'hard' scientists do – and, if one casts one's mind to relatively recent economics-related events,

it is not difficult to understand why.[4] However, for all its blemishes, economics remains our only port of call if we want to make sense of scarcity, market failures and free-riding. If this sounds a bit like a two-cheers-for-economics endorsement, well, yes, it is. But, blunt and crooked as it may be, economics is still the best tool we have to handle the three root causes of the climate problem.

1.1.1 Scarcity. Let me start from scarcity. Economics has been defined as 'the science which studies human behaviour as a relationship between ends and *scarce means which have alternative uses*'.[5] Or, if we want to put the emphasis on the outcomes of economic policies – exactly what I am going to do in this book – '[e]conomics […] is characterized by the study of how to obtain the best possible result from *scarce* resources.'[6] Indeed, if our resources were unlimited, most of what today we recognize as economics would either not exist, or be extremely boring. The choices economists study with their models are forced upon us by the fact that resources *are* limited, and extracting them is painful. And this is exactly where the link with climate change lies: the decisions we are confronted with when faced with the problem of controlling climate change are hard exactly because our resources are limited. If we could throw infinite resources at the problem, we would not have a climate problem any more: we could remove CO_2 from the atmosphere and store it safely (the technology to do so has been around for decades – it is just rather costly); we could deploy all kind of sources of renewable

[4] In November 2008 Queen Elizabeth II interrupted her scripted speech for the opening of the London School of Economics's New Academic Building to ask the impromptu question 'Why did no one see it coming?' She was referring, of course, to the Great Financial Crisis of 2008 that, just a few weeks before, had just reached one of its defining moments (the default of the American investment bank Lehman's Brothers). As far as I know, she never received a convincing answer.

[5] Robbins (1932), page 15, emphasis added. If the goal of economics is how best to make use of *scarce* resources, problems in economics are naturally cast in terms of *optimization*. The Integrated Assessment Models we will discuss in detail in the rest of the book are exactly an exercise in optimization. Casting the role of economics in terms of optimal allocation of scarce resources is today widely accepted, but it must be acknowledged that before the 1930s this interpretation was not mainstream among professional economists. See Backhouse (2010), page 100 and *passim* for a good discussion.

[6] Forni (2021), page 4, emphasis added.

energy without worrying about their cost effectiveness; we could throw unlimited resources into research about nuclear fusion, or other energy sources: that is, we could get ourselves the best and cleanest energy that money can buy. Unfortunately, we do not live in such a world of plenty. In reality, we cannot avert future climate damage *and* enjoy the same level of consumption we could have enjoyed had fossil fuels not produced a dramatic increase in the atmospheric concentration of CO_2 (and of temperature as a result).[7] Whoever peddles the fairy tale that we can successfully tackle climate change with little alteration of our lifestyles is either naïve, or ignorant, or in bad faith. If we truly want to bring climate change under control, the commitment to the task must be substantial – I often refer to it as a 'war effort', and I don't use this grim term lightly. It is exactly because the required resource commitment is so large that we must allocate our efforts wisely. And this is why economics – the science of scarcity – can help.

Given this background of resource scarcity, let me give an example of why unstructured abatement action can be counterproductive, even if we believe that the climate-change danger is 'clear and present'. Take the cost of solar panels. This has plummeted by more than 80 per cent over as short a period as ten years.[8] This is excellent news, and gives us real hope that energy from renewables may be able to provide us in the near future with a substantial fraction of our energy needs. However, the very speed with which costs have fallen should give us pause for thought. The lifetime of a solar panel is approximately thirty to forty years. If five to ten

[7] Carbon dioxide is not the only 'greenhouse' gas, nor the most potent. One should actually speak of 'CO_2 equivalent', that is, one should convert the concentrations and emissions of other gases to the equivalent CO_2 concentrations and emissions that would generate the same climate (temperature) change over a specified time horizon. For simplicity, I will mainly refer to CO_2, but one should really talk of CO_2 equivalent.

[8] To be precise, it has fallen by 99 per cent over the last four decades (Chandler 2018). Over the period 2010–2019 Solar photovoltaics (PV) have had a cost decline of 82 per cent. International Renewable Energy Agency (IRENA) (2019), *Renewable Power Generation Costs in 2019*, available at www.irena.org/publications/2020/Jun/Renewable-Power-Costs-in-2019. And as a salutary reminder that all our projections are just that – projections – it should be noted that the 2020 cost of energy per kWh from solar is less than a quarter than the International Energy Agency (IEA) 2010 forecast, and less than half its 2014 prediction.

years ago we had rushed into the deployment of the then-state-of-the-art panels, we would now be saddled with less efficient photovoltaic devices *for which we would have paid almost ten times as much as we can pay now.* True, those costly and not-so-efficient panels would have still somewhat reduced our emissions in the last five to ten years, and therefore made the climate problem today a bit more tractable.[9] However, deciding where the 'sweet spot' for action exactly lies – to what extent the advantage of waiting until we are 'smarter and richer' is negated by having to deal with a more difficult-to-handle climate problem – is clearly not easy. Thinking at the same time both about the falling prices of solar panels (and wind turbines, and carbon sequestration technologies), and about the increased severity of the climate events we are already observing makes us readily appreciate the nature of the problem, and why its solution is not easy: *since we are resource-constrained*, we must choose carefully how our abatement bullets are used.[10]

1.1.2 Externalities. Let me move to the second reason why looking at the problem of climate change through the lens of economic analysis makes a lot of sense: because the climate mess we find ourselves in directly results from a massive market failure. What does this mean? The green-

[9] Does this automatically mean that we would have been better off waiting and installing more efficient solar panels at a later date? Not necessarily. Solar panels have become as cheap as they have because so many of them have been produced, thereby improving our processes and our technological prowess. Innovations are not 'manna from Heaven', but are the fruit of what economists call 'learning by doing'. So, this example simply shows that, when it comes to abatement strategies, matters are always complex, and decisions have to be nuanced. For a discussion of learning by doing in the context of climate change, see, for instance, Messner (1997), who was among the first to introduce the idea that investment costs of technologies depend on the cumulative installed capacity, and van der Zwann et al. (2002) for a direct application to climate change.

[10] Matters, as usual, are a bit more nuanced. Suppose that we did delay the installation of the solar panels, waiting for more efficient ones to appear. As an anonymous reviewer of this manuscript pointed out, 'the decline in cost is also a result of the scaling and of the learning by doing and thus of someone investing sub-optimally. Could we have the prices of solar panel we have today if someone didn't invest sub-optimally ten years ago? In other words, pursuing the maximum efficiency objective may lead to a coordination problem whereby no one wants to make the first move, as it is suboptimal.' Excellent point.

house gases that we emit today will affect (negatively) the welfare of future generations, but these future generations are not compensated for the damage inflicted on them. The current price of a litre of gasoline comes from balancing *today's* supply and demand for gasoline (i.e., from the bargaining of today's buyer and seller), but no account is taken in arriving at this price of the huge unpaid bill left for future generations to shoulder. The existence of these 'unpaid bills' is well known in economics and the bills themselves go under the name of externalities. When the idea of externality first developed, the 1879 example was that of English cardiologist who could not hear properly the heartbeat of his patients because of the noise of the confectioner's machinery next door. Today, the textbook example of an externality is the noise the dwellers in the landing flightpath of an airport have to endure, without the ticket price negotiated between the airline and the passenger taking this into account. More generally, externalities arise when a transaction occurs between two parties (the purchase and sale of the litre of gasoline, in our example), but damages accrue to a third party who cannot have her say in the two-party bargain by seeking compensation (in the gasoline case, the third party today is the victim of pollution,[11] and tomorrow's third party are the generations who will have to face the costs associated with living in a hotter world). Economists therefore view as a key goal of the economic analysis of climate change the *pricing* of the externality arising from the emissions of greenhouse gases – a price that should take into account the damage they inflict.[12] Note that economists, being economists, do

[11] The pollution bill is not small: the WHO estimates that 4.2 million deaths per year are attributable to ambient (outdoor) pollution, and that worldwide air pollutants account for 29 per cent of lung cancers, 17 per cent of acute respiratory diseases, 29 per cent of strokes, 25 per cent of heart attacks (ischaemic heart disease), and 43 per cent of chronic obstructive pulmonary disease. We should keep these figures in mind when we discuss the pros and cons of nuclear energy.

[12] As usual, I am simplifying matters a bit here. In the domain of climate change, economists recognize three types of externality: the emission externality that we have just mentioned; the innovation externality; and the network-effect externality. The innovation externality arises because the benefits from innovations in climate abatement area are not fully appropriated by the inventors. This is why subsidies for research, when they fix this market failure, can make *market* sense. And as for network externalities, they are often associated with the building of new infrastructure, which will have to play a major role in the green transition. The classic example is that of electric vehicles and charging stations: installing more charging stations is held back by

not take a moralistic stance in arriving at this price: it is neither their intention nor their inclination to punish the 'bad' emitters. They simply ask the slightly otherworldly (and a bit 'impolite') question: for what compensation, paid by us today, would future generations accept the damage we are inflicting on them? If this sounds a bit crass and narrowly materialistic (and it is), let's not forget that if today's fuel users actually had to make this compensation payment, a very different equilibrium price for gasoline would be reached, and, as a consequence, we would immediately burn less fossil fuel. This would already be a big step in the right direction towards curbing climate change.[13] In reality the at-the-pump price of the emission externality is currently *negative*: large subsidies are enjoyed by the producers and consumers of fossil fuels – see the discussion in Section 12.4. No wonder we have the climate problem that we have: because we have probably engineered the greatest market failure in the history of mankind.[14] Prof Nordhaus (2021) puts it very clearly:

> Carbon capture and sequestration [CSS] provides a good example of this double externality. Economic returns on the research and

the small number of electric vehicles, and the production of electric cars is hampered by the scarcity of charging stations. In general equilibrium analysis one finds two equilibria: one with a lot of electric cars and charging stations; and one with few of both. Again, subsidies can help the establishment of one equilibrium over the other. For a good discussion see J H Stock (2021), *Driving Deep Decarbonization*, Finance and Development, IMF, September 2021.

[13] Let me be clear here: a market mechanism such as pricing today's emissions, and adding this 'emission tax' to the price of a litre of fuel works well in the idealized textbook world populated by *Homines economici*. Much as I think that market mechanisms, such as the establishment of emission markets, can to some extent help to tackle climate change, I do not think for a second that the invisible hand of the market has all the solutions to the climate-change problem. The reality of the 2017 *gilets jaunes* demonstrations in France are a stark reminder of how wide the gap is between the grubby sub-lunar world we live in and the rarefied world of the economics textbooks.

[14] I cannot be sure whether it is really the biggest market failure ever: however, the total world CO_2 emissions in 2019, including agriculture and land use, were over 40 billion tons. A *very* low estimate of the social cost of carbon puts it at around $30 per ton. (Some estimates are two-to-three times higher.) This means that the 'missing compensation' is at least well over one trillion dollars *per year*. This seems to me pretty large by any standards. To put the number in perspective it is the same size as the 'massive' infrastructure bill approved with bipartisan support by the US Senate in August 2021 – an investment that I do not think will be repeated every year.