How should we think about the economics of climate change?

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The name of Wassily Leontief is one of the most illustrious in economics and it is a special honour to receive a prize that bears his name. I am deeply grateful to all of those involved in the award. Whilst Leontief was insistent on the use of existing data to calibrate our models and is most famous for the fixed coefficients input-output model with no technical change, he was also deeply interested in the way in which technologies develop and in the role of humans as factors of production. I think, therefore that, he would have recognised both the immense importance of the problem of climate change, including its impact on what humans can do and where they can live, as well as the profound technological changes necessary. I also feel some closeness to Leontief, although I never met him, because I was greatly and directly influenced by his student Bob Solow and because my grandfather was from St Petersburg, where Leontief was born and took his first degree.

As an LSE professor, I also feel an affinity with Tufts. They are of a similar size and longevity. Their mottos are of a kindred and complementary spirit: LSE, "understanding the causes of things" and Tufts, "peace and light". And LSE's industrious and persistent beaver is highly complementary with Tufts wise and measured elephant. And the Grantham Research Institute on Climate Change and the Environment (which I chair at LSE) has similar purpose and vigour as Tufts GDAE.

It is also a great honour to be awarded the prize at the same time as my good friend Marty Weitzman. We first met almost 40 years ago in MIT in 1972, where I was working with Bob. We
discussed, if I remember, not only his pioneering ideas on prices and quantities which he was developing then but also, for example, overtaking criteria in optimum growth theory and market signalling. Ever since, I have been a great admirer of the depth of his work and his originality and have learned much from discussing climate change with him.

Thinking about the immensity of the issues raised by climate change forces us to think hard about the nature of the economics we should harness to analyse the making of policy to manage climate change. There is much in our basic toolkit of public economics which can provide valuable insights, in particular the theory of policy in a world where markets do not always work well and where inequality is of major concern. I shall make direct use of this approach in what I have to say. Indeed I will suggest that some of the more simplistic and misleading approaches to the economics of climate change have suffered from the ignoring of or the failure to apply modern public economics.

Important though this is, I want to raise questions which are more profound. How should we analyse policies to manage the effects of human economic and social behaviour that have potential impacts which are very uncertain, hard to describe, and in large measure many decades into the future, and, further, which are of a potential magnitude which could undermine the relationship of human beings to their planet, including where and how we can live? How do we analyse policy to promote a potential response which is essentially a radical and very wide-ranging industrial revolution? How do we do all this when delay looks very dangerous so that we probably have little time, or cannot risk taking that time, to learn more before embarking on action? How do we do all this when there is little or no historical experience of the dangers we face, where people do not directly experience the consequences of their actions today, or at least not very quickly? And how can people collaborate in responding to what is a global issue when many of them regard the problems as in large measure
the fault of others, when many appear to have concerns which seem to them more pressing, and some even want to deny there is a problem at all? This is no ordinary policy issue.

I want to argue that there is a great deal that our tools of economics can contribute, but that they have to be applied with judgement and care about how to handle the huge magnitudes and uncertainties involved. Further, we shall have to marshal the whole range of our subject, we cannot get by with just bits and pieces of the theory of policy. We will have to think hard about ethics. And we shall have to ask big strategic questions for which narrow comparative statics or comparative dynamics may not take us very far or even mislead.

Let us start with the problem because the logic of the underlying science shapes fundamentally the economics that we should bring to bear in its analysis. The logic of the science starts with people and ends with people. People emit through their production and consumption more greenhouse gases than the planet can absorb. This flow of gases therefore implies an increase in the stock or concentrations of these gases. The increase in concentrations means that more of the infra-red energy that is reflected from the earth’s surface is trapped in the atmosphere and this causes an increase in temperature. This global warming causes climate change which in turn directly affects peoples’ lives and livelihoods, including where they can live. The effects operate in large measure via water in some shape or form – storms, floods and inundations, droughts and desertification, and sea level rise. All the steps along the process are full of uncertainties. And the flow-stock nature of the process implies delay is dangerous.

The scale of uncertainty about the potential impacts make this a particularly difficult, worrying and fascinating problem. Anything like a continuation of current patterns of economic activity in the world, over this century, would likely add 300, or more, parts per million (ppm) to the approximately
435ppm of CO₂ equivalent of current concentrations. That could give us a probability of 30, 40, or 50% of exceeding a 5 degree centigrade increase in average global temperature relative to the mid-19th century, a hundred years or so from now. We have not been at such temperatures for more than 30 million years: homo sapiens has been around for approximately 200,000 years. Five degrees lower than now was fairly recent – the last ice age 10-12,000 years ago. That meant ice sheets south of Boston and close to London. People lived closer to the equator than those latitudes.

Such temperature increases transform where people can live. Changes in the upward direction of this magnitude would likely lead, for example, to the desertification of large areas and the inundations of others. It is the change that causes people to move. This is not comparative statics or even comparative dynamics. It is radical disruption and instability in a very short space of historical time. Such movement, if the history of population movements is any guide, would be likely to lead to prolonged, severe and global conflict. Development would likely be reversed in many or most parts of the world and we could have major decline, not growth.

These are not very small probabilities of major damage – these are large probabilities of a catastrophic transformation of the relations between humans and the planet. This story surely tells us that the challenge is about the management of potentially immense risks.

How can we think about such problems? One way that comes naturally to economists is to present the problem as one that can be formulated in terms of comparisons of expected utility under different policies or strategies. That approach can be useful and indeed, both Marty Weitzman and I have used it. But for me it should not be the primary perspective. The expected-utility approach, if it is to have applied substance, requires some ability to describe possible outcomes in specific ways, some ability to assign probabilities and some ability to attach valuations or utilities to outcomes.
The problem here is that some of the possible outcomes are potentially so dramatic and so far outside human experience that they are very hard to describe; indeed in my view our scientific friends are reluctant, perhaps excessively so, to provide even broad brush descriptions of the risks associated with 5, 6 or 7 degrees centigrade, in ways that can be understood in terms of effects on lives and livelihoods. Thus whilst science can and does give us some guidance on the probability of different temperature outcomes, that is to describe only an intermediate variable in the processes that affect human beings.

Of course, if we cannot describe implications for livelihoods very well, it is difficult to attach values. It is tempting to think of some of the possible outcomes as so catastrophic that we should be attaching unboundedly large or infinite utility losses. But people are not necessarily ready to pay infinite amounts, i.e. absolutely anything, to avoid world wars or very large losses in human life. For much of economics we can get by with avoiding confronting issues of the valuation of immense consequences, but not here. Applications of the expected utility approach in this context often also involve simplification to a one-good model, clearly missing crucial issues here, and the imposition of an underlying fixed growth rate, again missing crucial issues.

My inclination, however, is to think of this in terms of a challenge of managing extreme risks. We can form some view of the scale and nature of the risks we run. We can describe, in terms of the necessary scale of emissions reductions, how we can radically reduce these risks. We can see in large measure what is involved in changing our ways to achieve these reductions. And I will argue, the alternative paths are likely to embody a creative and innovative story of discovery, with strong growth and rising real incomes. Further, the destination, low-carbon growth, is likely to be very attractive: more energy secure, cleaner, quieter, safer, and more biodiverse.
This may seem a very broad brush way of looking at the problem but it is, I think, well-tailored in its structure relative to the problem and to our knowledge. And it gives strikingly clear results.

Let me illustrate. Scientists have argued, I think broadly convincingly, that the dangers of tipping points and runaway unstable dynamic processes imply that we should try to limit temperature increases to 2 degrees. There is no certainty on offer here so this is usually interpreted as a 50-50 chance of 2 degrees. Such a target will, of course, involve sizeable probabilities of being above 3 or 4 degrees with the associated great dangers. Nevertheless, it would be far less risky than anything like business-as-usual and many would be happy to see risks of 5 degrees centigrade or more cut from 30 or 40% to just a few per cent.

The emissions reductions required for this interpretation of a 2 degree target would involve cutting global emissions from close to 50 billion tonnes CO₂e p.a. now to well below 20 by 2050, i.e. by a factor of around 2½. With good policies, including on climate change, world output might grow by a factor of 3 in those 4 decades. Thus emissions per unit of output would have to be cut by a factor of 3 x 2½ or of the order of 7 or 8. In some sectors it may be difficult to cut by that amount, therefore in others we are likely to have to go to zero or negative emissions. That is surely a new industrial revolution by any serious definition. Further it must clearly encompass all sectors of the economy from agriculture, through buildings, industry, transport, to power since all involve emissions.

That this constitutes a revolution is, in large measure good news. In Chris Freeman’s (the eminent economic historian of technology) description there are 5 past major technological transformations: mechanisation of textiles (late 18th century); steam and rail (mid 19th); steel and electricity (end 19th); oil, automobiles and mass production (early 20th); information and communication technologies, ICT
(end of the 20th Century and continuing). They bring 2, 3 or more decades of creativity, innovation, investment and growth; and investment flows to the pioneers. One can quibble with timings or definitions but this key aspect of the story is clear. We now require a sixth: to our advantage it will overlap with the fifth, ICT.

This sixth wave of low-carbon technologies must, in contrast to all or most of the others, be driven by public policy. A key element of these policies will concern correcting the biggest market failure the world has seen – the failure to price greenhouse gas emissions. But we have to go beyond this fundamental insight of public economics and develop theories about how to foster radical and rapid change. I had some experience of this type of challenge when I was Chief Economist of the European Bank for Reconstruction and Development (EBRD) in the 1990s – the mandate was to foster the transition to the market economy. There were further criteria associated with democracy and the environment. The EBRD is largely a project-driven development bank, so we developed some simple-minded but useful indicators of the “transition impact” of projects. These were based, inter alia, on the potential power of the example, the ability to scale up, the enabling role of infrastructure, the training in more market approaches, aspects of finance which might provide for the leverage of innovation and change, emphasis on small and medium enterprises and so on.

In this low-carbon transition, one starting point for policy is the familiar approach of identifying market failure. As I have just emphasised, the first and most basic in this context is the externality associated with greenhouse gases. But there are at least five more of great relevance. Second, there is the positive externality of learning and new ideas. This is standard in economics but of crucial relevance here as discovering and demonstrating new approaches is central and there are great dangers of delay. Third, we have network and infrastructure externalities. Public transport, agricultural extension and distribution systems, power grids, combined heat and power are all highly
relevant examples of close interdependence amongst agents of decisions and investments. Fourth, many of the relevant investments are long-term and risky and capital markets have pervasive problems. Fifth, property markets have failures which seem to make it difficult for builders to capture returns to energy efficiency. Sixth, much of what firms and households can do may not be easy for them to discover, understand or implement – there are information problems and transaction costs, again of greater relevance than normal because of the emphasis on change. All too often some have argued as if the greenhouse gas emissions was the only important externality, thus ignoring some of the most fundamental insights of modern public economics on the interaction of market failures.

This tells us that we must go way beyond a price for carbon. This standard approach of modern public economics of examining the many related market failures while valuable is, however, only a starting point. Our subject of economics must work much more directly on the theory and empirics of how to foster change. Political economy, vested interests and obstacles to change must be part of the story. For example, in India fertiliser subsidies were introduced half a century ago to encourage the use of “new” chemical fertilisers – they became hard to remove and they are still there. We must focus on how the power of the example encourages learning. We should examine how time paths of powerful incentives such as feed-in tariffs should respond to the learning they induce. And the question of how to combine policy instruments is likely to be of great interest. The dynamic interaction of public policy and private investment is at the heart of the story. I could go on but I simply wanted to emphasise the importance and fascination of a more dynamic approach to the policy challenge of fostering a transition.

Economists rightly focus on market-based incentives. We ignore them at our peril. But in this area, as in many other policy challenges concerning changing behaviour, discussions of responsibility and
ethics are of great importance. Many of us do not drink-and-drive because we think it is irresponsible and wrong, as well as because of our understanding of penalties. That view of irresponsibility has changed dramatically over the last four or five decades as a result of public discussion and information. There was a widespread narrative when drink-driving laws were introduced in the UK in the 1960s which went as follows. It is an unwarranted and intrusive restriction in personal liberty to restrict a man (it was usually a man they had in mind), who had just got a car and a bit of money, from driving to the pub, having a few pints and driving home. Happily we now regard such arguments as astonishingly irresponsible: but they were widely accepted then. They have changed through public discussion and the assembly and the examination of evidence.

Similar ideas of information and responsibility are associated with drugs, smoking, alcohol more generally, safe sex and littering. They are not minor examples in public life.

Explicit treatment and discussion of ethics is central to this challenge, whether we rely to some extent on perceived responsibility or focus only on economic incentives. The issues of intra-temporal and inter-temporal justice and values are fundamental to assessments of policy. Climate change is a highly inequitable process where it is the richest groups and countries that contribute, and have contributed, most to emissions and, whilst we will all suffer eventually from unmanaged climate change, it is the poorest countries that will be hit earliest and hardest.

I should emphasise that some aspects of policy can be derived from fairly weak ethical positions. Since unpriced greenhouse gases are a market failure, this is inefficient. We could make both our generation and future generations better off by bequeathing them a better environment and less of standard capital goods or infrastructure; or indeed a larger debt.
We must remind ourselves also that there is a whole host of reasons why we cannot reduce or delegate the problem of constructing inter-temporal valuations to an appeal to markets to settle issues of discounting. There are many features of capital markets which imply that they cannot provide the relevant information. These include first, the basic observation that the time path of living standards, which shapes discounting, is itself strongly influenced by our policies: thus discounting cannot be exogenous to policy choice. We may be much poorer from the unmanaged climate change that might follow from high discounting, thus undermining a key argument for high discounting. Second, there are no markets which reflect collective very long-term decision-making. Third, those markets that do exist are full of imperfections. Fourth, there is more than one good here, environmental services are clearly central, and the changing relative price of the environment and standard consumption implies that a single discount rate will not do.

I could go on but enough has surely been said to demand an explicit discussion of the ethics that should underlie policy on climate change. There are many possible perspectives, including notions of rights, responsibilities, stewardship and justice as well as those more standard in economics. In my view whichever of the ethical perspectives adopted, the arguments for strong and urgent action are very powerful.

There are many other aspects of this issue for which our current tools in economics have great value but for which we also need creativity in application and advance in the tools themselves. I have said little about the crucial subject of adaptation and how to defend against and respond to major changes in climate when those changes themselves are hard to predict and where history is a weak guide. The battle against deforestation involves subtle and complex inter-relationships between development, agricultural development, water, construction and urbanisation and so on.
Of special importance and fascination is the whole set of issues around promoting international collaboration. These have occupied much of my time and energy since the publication of the Stern Review. There is great complementarity and dynamics between top-down agreements and understandings across nations and the bottom-up actions of individual nations. It is in large measure about credibility, trust and mutual confidence. And in my view and experience formal legal frameworks are far from the only or most important vehicles for generating that mutual confidence. For example, a basic knowledge of the history of planning in China gives substantial confidence in predicting China’s future behaviour from their 12th five year plan (2011-2015), a remarkable programme for change towards a low-carbon economy, which is an internal commitment within China; indeed surely much greater confidence than in predicting Canada’s emissions from its signature to the Kyoto Protocol, a so-called legally binding international agreement.

China's 12th five-year plan is of great importance and charts a new low-carbon road for that vast country. I do not know whether they can accelerate, as the numbers require, but it is a good start. And I hope that the USA’s hesitation over the last couple of years is temporary. Perhaps the US will accelerate as it sees progress elsewhere and the threat of being left behind or shut out.

The economics of climate change is a subject which involves issues of extraordinary importance - essentially, for many people, existential. But I have also tried to argue that it involves moving beyond some of our standard formulaic approaches within economics. Our subject has a great deal to offer. But it has to be applied with real creativity and imagination. Further, we have to be ready to look beyond the margins of our own subject to science, technology, philosophy, economic history, international relations and so on. And we have to be prepared to develop more dynamic tools of analysis to focus more closely and directly on how to foster change.
The economics of climate change is a subject of extraordinary fascination and importance. Our ability to understand this subject and to act on our understanding will determine whether we can rise to the two defining challenges of our century: managing climate change and overcoming world poverty. If we fail on one we will fail on the other. I believe Leontief himself would have recognised the fundamental importance of climate change and would have been immediately attracted to the challenges of its analysis. It has been a great privilege and honour for me to be here in Tufts today to receive the Leontief Prize. I am deeply grateful to you all.