14 BETTER ENERGY AND CLIMATE POLICY

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EU climate policy is too heavy on grandiose targets and draconian regulations. It is too light on more modest measures, which might be a more effective European contribution to addressing what is a global problem.

Of course, British politicians have not been passive victims of the development of EU climate policy. There have been some exceptions recently, but the general pattern is still that the British government has been among the most enthusiastic advocates for more ambitious targets, and more draconian climate regulations.

That does not mean that the EU does not bear a significant measure of blame for the dysfunctional state of UK climate policy. The effect of EU-level policymaking in this area is not primarily in the regulations that were put in place; it is the fact that they are still in place.

Since the direction of EU climate policy was set, there have been a number of crucial developments: the diplomatic process that was supposed to lead to a binding global climate agreement at the Copenhagen Summit in 2009 has failed; despite a notional success at the more recent Paris conference, the major emitters have still not committed to binding emissions targets comparable with those embraced by the EU; it has become clear that the requirements of some of the EU's policies are very onerous, particularly the renewable energy targets, which the government

is keen to avoid renewing; the recession has meant that there are a whole range of other pressures on family living standards; and the burden of climate policy has compounded the challenge of necessary fiscal adjustments.

All those developments should have been the spur for a new and more appropriate set of climate policies. Former Canadian Prime Minister Stephen Harper and former Australian Prime Minister Tony Abbott announced their opposition to carbon taxes and emissions trading in June 2014, with Harper saying that action to mitigate climate 'must not destroy jobs and growth in our countries' (Kennedy 2014). Unfortunately, in Europe the changes have been superficial. The same dysfunctional structure of climate policy is still in place.

The new and difficult problem of decarbonising modern, industrial economies – one group of academics has described it as a 'wicked' problem for the complexity of the systems policymakers are trying to control (Prins et al. 2010) – was never well suited to the EU. Politicians saw the supranational scale of the EU as an advantage, but that scale has actually meant too little flexibility to try new ideas, see which work best and quickly reform or scrap those measures that are proving ineffective. British ministers too often simply take EU targets as a given. They look no further than the next steps along a proscribed road to meeting those targets, rather than lifting their eyes to the horizon and considering a better direction altogether.

Climate policy is therefore quite different from policy areas such as the Common Fisheries Policy (Rotherham 2009, and Chapter 10 of this book) or the regulation of financial services (Europe Economics 2014, and this volume's Chapter 13). The principal problem is not that our interests differ, or that we have a different conception of how the regulations should function. In most other member states, the present direction of EU climate policy creates similar problems to those it is creating for the UK, although the scale of the problems created does vary.

If the UK leaves the EU, there will be a natural opportunity to think again about the direction climate policy has taken thus far. If the UK remains a member state, climate policy will remain a crucial test of whether a bloc of 500 million people and nearly thirty member states is too large and unwieldy to fulfil its own ambitions – an ocean tanker in a world that rewards agility.

I will try to do three things in this chapter: explain the depth of the challenge facing a society wanting to emit less CO_2, and persuade you that you should probably care less about whether computer models of the climate are reliable, and more about whether the policy being pursued is effective and affordable; set out why the EU's climate policies are failing, and why they are unlikely to be fixed with modest reforms; and, finally, I will propose an alternative course of action, which I think would be more realistic, more effective and less of a burden on families and businesses. I hope we can consider an alternative, in or outside the EU.

The problem

Wrigley (1988) described how energy, generated by burning fossil fuels, was crucial to the Industrial Revolution. An enormous supply of energy was available, and using more energy did not mean more pressure on agricultural land and therefore the food supply. He cited Émile Levasseur – a nineteenth-century French economist – who wrote that steam engines were providing the equivalent of 'deux esclaves et demi par habitant de la France' (two and a half 'slaves' for every inhabitant of France). Update his calculations to reflect final energy consumption, and each inhabitant of Britain enjoyed the services of 97 mechanical slaves in 2009 (Sinclair 2011: 34).

We should therefore not be surprised that since the Industrial Revolution economic growth has been associated with increasing fossil fuel consumption. Equally, we should understand why

attempts to restrict the use of fossil fuels and use more expensive sources of energy could have enormous implications for our future standard of living. There are consequences to giving up the services of those mechanical slaves or paying them more.

If climate policy is to be a realistic political prospect, it cannot be premised on voters accepting substantially lower incomes now, in return for somewhat lower temperatures at some point in the future. Pielke (2010) called that the 'iron law' of climate policy.

There have been concerns for some time that fossil fuels might not be a sustainable basis for continuing economic growth. The first objection was that the supply of fossil fuels was limited, and, over time, they would become steadily scarcer and more expensive. The Bureau of Mines in the US warned in 1914 that US oil reserves would be exhausted by 1924. The Department of the Interior warned in 1939 that the world's petroleum reserves would last thirteen years. Those predictions and others since (Will 2010) have steadily been proven wrong, as new reserves have often been discovered or become profitable to extract more quickly than existing reserves have been depleted.

The most recent and most striking example of this is the enormous development of shale gas and other unconventional resources in the US. The US produced five million barrels of crude oil a day in 2008; it produced around seven and a half million barrels a day in 2013, a 50 per cent increase in five years (US Energy Information Administration 2014a). It produced around twenty trillion cubic feet of natural gas in 2008; it produced more than twenty-four trillion cubic feet in 2013 (US Energy Information Administration 2014b). Other new resources are being developed. The Japanese government has been investigating the potential to access enormous reserves of methane hydrates, which are found near coastlines on the ocean floor (Mann 2013).

The second and more credible objection to the continued and increasing use of fossil fuels to power a growing industrial

economy is that resulting greenhouse gases will contribute to dangerous changes in the global climate. The Kaya identity – named for the Japanese economist Yoichi Kaya – describes how economic growth will tend to increase greenhouse gas emissions, though the process will be moderated if the emissions intensity of GDP is falling (Prins et al. 2010):

> Emissions = Population × GDP per capita × Energy intensity of GDP × Emissions intensity of energy

We can expect that so long as fossil fuels constitute the most reliable, available and affordable source of energy for most purposes, this basic relationship will hold. The emissions intensity of GDP does tend to fall over time, but the world economy tends to grow fast enough that global greenhouse gas emissions continue to rise.

The Royal Society (2014) reports the current conventional scientific understanding of the implications of rising greenhouse gas emissions:

> Greenhouse gases such as carbon dioxide (CO_2) absorb heat (infrared radiation) emitted from Earth's surface. Increases in the atmospheric concentrations of these gases cause Earth to warm by trapping more of this heat. Human activities – especially the burning of fossil fuels since the start of the Industrial Revolution – have increased atmospheric CO_2 concentrations by about 40%, with more than half the increase occurring since 1970.
>
> [...]
>
> If emissions continue on their present trajectory, without either technological or regulatory abatement, then warming of 2.6 to 4.8 °C (4.7 to 8.6 °F) in addition to that which has already occurred would be expected by the end of the 21st century.

As the Royal Society (2014: 5) notes, the greenhouse effect itself has been well established in experimental science. However, there is considerable uncertainty over the scale of the complex positive and negative feedback expected to amplify or mute that initial effect. Uncertainty over that feedback (without which expected climate change would be considerably more modest) results in the substantial range for expected warming. It is also the basis of most criticisms from sceptics of the current, conventional science.

Increases in global temperature are expected to create a range of harms. Those harms are best expressed in terms of the social cost of carbon, the expected harms now and in the future of emitting a tonne of CO_2-equivalent greenhouse gas.[1] Nordhaus (2011) estimates the social cost of carbon to be $12 per tonne of CO_2 (in 2005 prices). His results are comparable with the wider literature, and there does not seem to be a trend upwards or downwards in estimates of the social cost of carbon over time (Tol 2011). However, the social cost of carbon itself is expected to steadily rise over time.[2]

Those with relevant expertise will continue to debate the science of climate change, but it is unrealistic and unhelpful for policymakers to insist on a greater degree of certainty than researchers investigating a complex system such as the global climate can reasonably be expected to provide. Time, energy and talent have been wasted debating the validity of climate models, which could have been better used in scrutinising the policies purporting to reduce emissions.

1 CO_2 is the most important greenhouse gas overall and the most pressing challenge for policymakers, but other greenhouse gases are significant and often make a greater contribution to the greenhouse effect for each tonne emitted. For example, methane is expected to contribute 21 times as much as CO_2 to global warming for each tonne emitted over a 100-year time horizon.

2 There is also the more remote possibility of a catastrophic outcome (Weitzman 2009), and much higher social costs, but many attempts to distinguish climate change from other potential catastrophes are based on 'armchair climate science' (Manzi 2008).

Once you start to scrutinise those policies, it becomes clear that, whatever understanding you have of the science of climate change, it does not change the conclusion. European climate policy is failing on its own terms.

The EU response

Climate policies adopted across the developed world have been remarkably similar. Prins and Rayner (2007) argue that the Kyoto Protocol was created by 'quick borrowing from past practice with other treaty regimes dealing with ozone, sulphur emissions and nuclear bombs' and fails because it relies too heavily on an unrealistic attempt to create 'a global market by government fiat, which has never been done successfully for any commodity'.

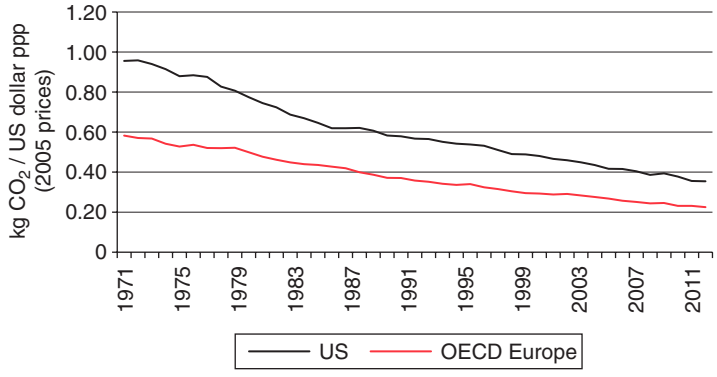
There are four principal elements to EU climate policy:

1. targets for emissions reduction;
2. the Emissions Trading System (EU ETS);
3. renewable energy subsidies;
4. green taxes.

There is also a range of requirements for greater energy efficiency (for example, in regulations setting requirements for average fuel efficiency for motor vehicles).

While the EU stands out in terms of the degree to which it has adopted ambitious targets and policies aimed at reducing greenhouse gas emissions, it does not stand out in terms of reductions in emissions intensity. To the extent that the EU has reduced emissions relative to – for example – the US, it has done so because its economy has grown more slowly (see Figure 5). At the same time, there is no discernible change in the trend for emissions intensity in the late 1990s and early 2000s with the introduction of the principal climate change policies. European climate policy does not appear to have been effective in terms of reducing emissions intensity thus far.

Figure 5 **Emissions intensity, Europe versus the US**



I will not set out all the detailed problems that have beset the current policies.[3] I will instead focus on why they have not just failed so far but can be expected to continue to fail, even if reforms address some of the more minor issues in the future.

Targets for emissions reduction

There are now three important sets of targets for emissions reductions. The EU as a whole is to reduce emissions by 80 per cent below 1990 levels by 2050; 40 per cent below 1990 levels by 2030; and 20 per cent below 1990 levels by 2020.

Without remarkable progress in reducing emissions intensity, those targets have the potential to require dramatic reductions in living standards. The Kaya identity makes it easy to understand why that is the case. If an economy were to grow at a little over 2 per cent a year from 1990–2020 and reduce its emissions

3 See Sinclair (2011) for a more comprehensive and detailed analysis of the various policies enacted in various member states and elsewhere.

intensity at a similar rate, as developed European economies have over the same period (2.2 per cent from 1990 to 2000; 2.1 per cent from 2001 to 2011), then the result is obvious: it would take a reduction in national income of 20 per cent from the expected level to cut emissions by 20 per cent. If the EU is not able to do better, then the targets will require a reduction in national income to 40 per cent below expected levels by 2030.

Pielke (2009) studied the UK's targets under the Climate Change Act using the same method and concluded that the rates of decarbonisation needed (4–5 per cent a year, on average, over decades) would be unrealistic compared with the record up to that point. Very little has changed since, except that a recession has reduced GDP below the level expected and therefore made the short-term targets easier to meet.

Despite all that sacrifice, meeting the targets would not necessarily make any significant difference to the expected global temperature. Crucially, those targets are for reductions in producer emissions (emissions produced in member states of the EU), not consumer emissions (emissions produced supplying demand in the member states of the EU). Helm (2009) describes the problem this creates:

> This international dimension raises perhaps the most important aspect of the 20 per cent overall target: it is based on production of carbon within the EU, and not on consumption. Thus the EU can achieve its targets if it switches carbon production that would have taken place within the EU to overseas, and then imports back the goods and services which would have caused the emissions internally. And, to the extent that energy-intensive industrial production is shifting globally from developed to developing countries (which it is), the 20 per cent target can be achieved without reducing carbon concentrations globally by the implied amount. Indeed, if the production techniques in developing countries are less carbon-efficient

than in developing countries, and if we add the emissions from shipping, aviation, and other transport, it could even increase emissions.

Research for the British government has found that this is not just a theoretical issue. While UK producer emissions (emissions in the UK, whether the relevant activity is serving domestic or export consumers) fell by 20 per cent between 1990 and 2009, consumer emissions (emissions serving UK consumers, whether they occur within the UK or abroad) rose by 13 per cent (Scott and Barrett 2013).

The targets only make any sense in the context of a global agreement. The process by which such an agreement was supposed to come about collapsed at the Copenhagen summit in 2009. Thanks to *Der Spiegel*, we even have a recording of the moment at which EU leaders failed to secure the support of the major emitters they would need to make such a global agreement meaningful, with Nicolas Sarkozy accusing the Chinese government of hypocrisy (Rapp et al. 2010). An accord was eventually reached without European leaders in the room.

Many of the developed economies that were supposed to be bound by the Kyoto Protocol have subsequently repudiated it or rejected the use of specific climate targets. The US Senate made clear that they would not ratify the Protocol. Japan reduced its emissions target for 2020 in 2013, to 3.8 per cent below 2005 levels (3.1 per cent above 1990 levels). Canada withdrew from the Protocol in 2011. In Australia, legislation to establish a carbon tax first appeared set to be passed with bipartisan support. That bipartisan support then collapsed (taking the career of Malcolm Turnbull, then leader of the centre-right Liberal Party, with it). The central carbon tax was eventually passed, but despite a campaign pledge not to introduce it, and in the face of opposition from a Liberal Party then elected to form a new government, who pledged to repeal the regulation.

Targets for cuts in producer emissions without international coordination are not meaningful. They can enormously distort policy, which is constantly judged in terms of whether it meets the targets, rather than whether a policy is effective and represents good value. Even when and if each set of targets is met, it can be a hollow victory if emissions are rising elsewhere.

Emissions trading

Under the EU ETS, relevant organisations[4] are required to hold an emissions allowance for each tonne of CO_2 they produce. Those allowances are either allocated or auctioned and can then be traded, generating a market price and therefore creating a cost (buying an allowance) or opportunity cost (not selling an existing allowance). That creates a neat incentive for firms to cut emissions in the least expensive way possible in theory, without requiring politicians to set a price.

There have been a number of problems with the implementation of the EU ETS: fraud, which, at one point, accounted for 90 per cent of trades on some markets (Europol 2009); significant windfall profits, even in competitive markets, as firms were given allowances for free, but the need to hold those allowances increased the marginal cost of production and therefore prices (Sinclair 2011); and member states allocating too many allowances to their firms, leading to an early collapse in the price and a transfer from UK firms of around £1.5 billion over the first three years, as the British government was more parsimonious (Open Europe 2006). The carbon floor price further increases the burden on British industry, without cutting overall emissions at all (Sinclair 2011).

However, it is also important to understand that the problems the ETS has faced are not simply a result of flaws in its

4 Over 11,000 power stations and industrial plants in 31 countries are covered, plus airlines. See http://ec.europa.eu/clima/policies/ets/index_en.htm (accessed 14 September 2015).

implementation. Reforms have addressed some of those initial challenges, but they cannot address its more fundamental weaknesses.

The most pressing problem facing the EU ETS is the sheer instability of the carbon price. It has repeatedly collapsed (Sinclair 2009): first when it became clear that many countries had over-allocated emissions allowances to domestic industries, and then again when the recession led to a reduction in demand. That instability has two crucial effects: it undermines the effectiveness of the carbon price in encouraging investments to reduce emissions, as those investments are subject to greater risk; and it exacerbates the burden on industry as firms struggle to plan with an uncertain component in their costs.

That instability in the price was thought to be a result of the various problems in the implementation of the EU ETS. Actually, the problem is that, unlike in other industries, where the impact of an increase in demand on prices is mitigated by an increase in supply, in the emissions market supply is fixed. That means any change in demand is entirely reflected in the price.[5]

That might not matter if demand were predictable, and the supply of allowances could therefore be planned to ensure a reasonable price. Unfortunately, demand is inherently unpredictable: governments cannot predict recessions; all kinds of policies can be enacted by the EU or individual member states; new technologies can disrupt the market. The carbon price will always be unstable. It could spike in the future, causing enormous economic harm, as easily as it has collapsed up to now. Instability in the price will always undermine the efficacy of emissions trading.

5 It is easier to understand this problem if you think about other markets in which supply is fixed, such as the housing market. When more people want to live in a city where construction is easier, more houses are built. In places such as London, where supply cannot keep pace, prices increase sharply. Krugman (2005) characterised housing markets that saw a boom in prices before the financial crisis as making up the 'Zoned Zone', and those where more housing could be constructed, and a boom therefore never get started, as the 'Flatland'.

Renewable energy subsidies

Twenty per cent of final energy consumption in the EU as a whole must come from renewable sources by 2020. The targets for individual member states vary, and the UK target is the most ambitious.

Onshore wind has generally cost about twice as much as conventional energy,[6] offshore wind has cost about three times as much, and solar has cost even more. That would not necessarily be a lasting problem if we were willing to be patient. Over time, those technologies might become more affordable. However, the rate of improvement is often overstated: a key official target for a reduction in the cost of offshore wind appears likely to be missed (Sinclair 2013); progress in reducing the cost of solar power is real but overstated, as proponents of the technology mix up lasting technological progress with the temporary effects of Chinese industrial policy.

However, we are trying to push prohibitively expensive technologies into action now, using the lure of extravagant subsidies to secure private investment. Over £200 billion of investment is needed in the UK energy sector by 2030 in addition to the around £150 billion that would be needed to maintain supply without the decarbonisation targets (Atherton and Redgwell 2013). The implications are obvious: profits have to rise so investors can make a return on that enormous investment, and prices then have to rise to pay for those profits.

There does not seem to have been any plan for how the public would be persuaded to accept that outcome as legitimate. It is quite easy for campaigners with an axe to grind to portray that combination of rising prices and rising profits as evidence that energy firms are profiteering at the expense of consumers.

6 There is a debate over the aesthetic qualities of onshore wind. My sense is that both sides are right: onshore wind turbines are not ugly in themselves, but they make many views less beautiful. New York is a beautiful city, but that does not mean there would be nothing lost if we covered the Lake District in skyscrapers.

On one level, that story is accurate: firms are going to make larger profits at the expense of higher prices for their customers. But those higher prices and profits are necessary for climate policy to be effective. They are a feature, not a bug, of the measures put in place by exactly the same politicians now lambasting those companies for supposed profiteering.

Investing enormous amounts of money in deploying uneconomic renewable energy is therefore expensive and not politically sustainable. There have already been retrospective subsidy cuts in Spain and an effective windfall tax in Germany, in the form of the tax on nuclear assets (Atherton 2010: 10), and those political risks mean even higher returns are needed.

The normal criticism of government interventions designed to subsidise specific technologies is that they are trying to pick winners. Here, governments are instead almost deliberately picking losers. The most expensive sources of energy receive the most generous subsidies. They are doing this because the targets are sufficiently ambitious that every opportunity to increase the use of renewable energy has to be taken, even if – as in the case of renewable heat – the costs are clearly greater than the benefits (Renewable Energy Forum 2010).

Politicians should be working to support the development of economic alternatives to fossil fuels for the future. Instead, they are focused on targets to deploy inadequate alternatives now. The tail is wagging the dog. The short-term costs are enormous at a time when there are many other priorities for investment, and many other pressures on the living standards of European families.

Green taxes

Many economists regard green taxes as the ideal climate policy. Mankiw (2006), for example, has advocated higher taxes on motor fuels and termed the 'elite group of pundits and policy wonks'

who support higher Pigovian taxes[7] the 'Pigou Club'. Worstall (2010) called for a broader, neutral carbon tax and the repeal of other climate policy. They argued that a carbon tax could correct for externalities, and people would then only consume fossil fuels if the benefit to them was worth more than the costs to others. Further regulation would not be needed. All that is much easier said than done.

First, you need to establish the correct social cost of carbon, the right level at which to set a carbon tax. There is an enormous range in academic and official estimates of the social costs of climate change, and they can vary enormously depending on your assumptions, such as for the long-run discount rate (Tol 2011).

Then you need to take into account all the other positive and negative externalities. Motoring taxes at European levels cannot be justified by the social cost of carbon alone (Dunn 2009). Proponents of higher taxes therefore add other externalities, from the costs created by accidents via traffic noise to congestion on the roads (normally the largest component). They rarely include the many positive externalities associated with driving, such as reduced congestion on public transport.

All kinds of inequities emerge. Why do we not apply an emissions tax to agriculture, to account for the methane produced by ruminating cows?[8] Why are motorists subject to taxes to account for the noise they create but factories, for example, are not? Why are motorists subject to taxes to account for the particulate emissions their cars create, when those particulate emissions are already regulated in other ways?

You can view these double standards as a lamentable result of the political process, and not an indictment of the policy in itself.

7 A 'Pigovian Tax' is intended to correct market prices for 'negative externalities' – costs imposed by economic activity that are not fully paid for by those benefiting from the activity. The first economist to advocate such taxes was Arthur Cecil Pigou (1877–1959).

8 Instead, we subsidise farms handsomely.

The reality is that the Pigovian principle of intervening to align private incentives with the social good can justify such a wide range of taxes and subsidies, and is so analytically complex, that it just becomes a rationale for politicians to impose whatever taxes they like. Or, as Manzi (2009) put it:

> In order to achieve the 'fairness and social optimality' that we started with when discussing the [global warming] effects of carbon, we are logically led to demanding that the government measure the social value of almost every economically significant action, and then set up incentives to manage the population so as to achieve social goals. Because this is an impossible analytical task, in practice this means the purely political management of society based on relative power. What is this but unadulterated socialism in a green dress?

Green taxes also start to confuse the point of the tax system. Is it a means to raise revenue, or an instrument of social control?

Many policymakers like to imagine a neat transfer from reliance on taxes on labour income, for example, to taxes on greenhouse gas emissions. The Chancellor of the Exchequer – George Osborne (2006) – entitled a speech in opposition: 'Pay as you burn, not pay as you earn'. Unless these taxes are expected to be entirely ineffective in changing behaviour, there will be a shortfall in funding as emissions intensity falls. Greater instability will be introduced into the tax system.

Vehicle Excise Duty was reformed to make the rate more dependent on vehicle emissions, and revenue has steadily declined as cars have become more efficient. Politicians are now considering expensive new reforms to make up the difference (Odell and Pickard 2012).

Of the three main policies that are in place now, green taxes look the best on an economist's blackboard. There are better alternatives that reflect a more realistic role for government. The

tax system is best left with one simple, but more than challenging enough, objective: creating the least economic distortion possible while raising the revenue needed to finance government services.

An alternative

It is important to note that all the policies discussed in the last section really require global government. The EU has been seen as a second-best alternative – emissions might be less likely to leak outside its wider borders – and as a more effective interlocutor with global institutions, with greater negotiating weight than any member state negotiating alone.

In both respects, it is failing. The International Energy Agency (2013) currently expects that, due to high energy costs, resulting from climate policy and a failure to match US development of domestic hydrocarbon reserves, Europe will lose 10 per cent of the global export market in emissions intensive industry by 2035. Chemicals firm BASF recently announced it is shifting investment to the US (Gummer 2014), and where investment goes today the balance of economic activity will go tomorrow. And, as mentioned earlier, European leaders were not even in the room when the Copenhagen Accord was finally negotiated (Rapp et al. 2010).

The crucial reason why climate policy has gone so wrong is that policymakers have been answering the wrong question. They have been answering the question: 'If there were a global government that wanted to restrict emissions, what would it ask European member states to do?'

They are waiting in vain for a final global deal. Politicians in the major emitting economies will not bind themselves to restrict emissions if it entails substantial increases in energy costs for families and businesses in their country. Even modest increases in energy costs have led to riots (Pielke 2010) and revolutions in developing countries; when push has come to shove, developed

countries outside Europe have not put compliance with the Kyoto Protocol before their economic health.

I think a much more meaningful question is this: 'What can European member states, which make a limited contribution to global emissions, but which possess considerable financial and technical resources, do to improve our chances in the face of potential climate change?'

What would you do, if you had £1 million, £10 million or £100 million and were asked to do something about climate change?

I do not think you would achieve very much spending the money subsidising an offshore wind turbine. I think you would be much better advised to either take sensible precautions to ensure that your crops, your home, your transport infrastructure and your rivers and coastline were not disrupted more than they needed to be if the climate warmed, or fund the development of new alternatives to fossil fuels by supporting new research.

Defenders of the current approach might argue that governments have funded measures to adapt to climate change, and they have funded R&D. The Technology Strategy Board has helped to fund a new Longitude Prize, and several of the options they are considering relate to climate change. Those efforts have largely been a distraction at the margins of climate change policy. Funding for adaptation has often been shorthand for attempts to bribe developing countries to participate in international climate change deals.

There is a role for supranational institutions in the kind of climate policy that I will sketch out here. They could have a non-trivial role as fora in which countries can share best practice and perhaps agree on a sensible division of labour. However there is no need for the kind of grand, utopian global deals upon which current climate policy was always premised. The best climate policy does not really need the EU. Whether or not better climate policy is possible inside the EU depends on whether the institutions can show a new flexibility in this area.

Resilience

No country is safe in the face of natural disasters, but the consequences tend to be far more severe in poorer countries with dysfunctional institutions. People are poorer and therefore closer to the edge, more likely to be malnourished or in ill-health already. Institutions are weaker and therefore will be slower in recognising problems and less able to provide support to those affected. As most countries have become more prosperous and more democratic since the 1920s, 'mortality and mortality rates have declined by 95 per cent or more' (Goklany 2007).

It is not only in surviving natural disasters where we can expect economic and political progress to translate into a greater ability to withstand the harms associated with climate change. More prosperous and well-run countries can wring greater agricultural productivity from difficult climates (for example, Israel). They can manage the waters even in low-lying, vulnerable places (e.g. the Netherlands).

The last thing we would want to do in the face of an uncertain threat such as climate change, and a wide range of other potential risks, would be to erode our prosperity. 'In the face of massive uncertainty, hedging your bets and keeping your options open is almost always the right strategy. Money and technology are our raw materials for option' (Manzi 2010).

Adaptation

To the extent that we do not mitigate climate change, we will have to adapt to it. Nordhaus (2008) studied a number of options to limit greenhouse gas emissions and found that even the most ambitious plan, limiting the rise in temperatures to 1.5 °C and costing over $27 trillion (2005 prices), would still allow nearly $10 trillion of harms (or nearly half of the harms expected in a

scenario where no action is taken for 250 years). There is no practical scenario where we expect no significant warming.

The problem that we are most concerned about when it comes to global warming is an increase in the incidence of existing problems: drought in hot and dry regions, flooding in low-lying areas and more extreme weather of all kinds. Floods in Bangladesh are a problem worth addressing, regardless of what you expect from global average temperatures. There is no harm in getting some of our adaptation in early.

Adaptation can take place as and when the impacts of climate change start to be felt. It is therefore far easier for adaptation to adapt and improve over time. Lilico (2014) argues that by 'adapting as and when we need to, we cut down on the risks of doing something counterproductive by accident or of simply wasting our time and money.' We will be able to respond to the actual harms created by climate change, rather than those expected by scientists studying complex natural systems. Only in a small number of situations such as coastal defence and adapting transport systems are grand plans and long lead times likely to prove necessary.

Many of the changes that are needed will be made without any government intervention at all. If farmers are well informed and drought-resistant crops are available, they will use them. If it gets hot in the cities and people are not prevented from doing so by regulation, they will install air-conditioning.

The most dramatic measures that we might take in response to a warming climate are geo-engineering projects. They fit in a grey area between adaptation and mitigation. There is clearly the possibility that injecting large volumes of sulphur dioxide into the stratosphere or dumping large volumes of iron ore into the ocean could limit the harms created by global warming, but they might create a range of problems of their own. The unintended consequences could be severe. We should be doing our research, though, just in case we really are dealing with a potential catastrophe.

Technology

The final area in which there is enormous potential for action is in producing new technologies that might help us adapt to or mitigate global warming.

Every ambitious strategy to mitigate climate change is at some level a technology strategy. There is no way that targets to decarbonise the world economy will be met without enormous reductions in emissions intensity. The sacrifices needed in living standards would be too severe. Politicians hope that, if they create the carbon market, then the technological developments will come.

The problem with that strategy is that, in the meantime, we are installing inadequate alternatives to fossil fuels, such as offshore wind turbines, on an enormous scale at huge cost. If it does not turn out that revolutionary reductions in the cost of offshore wind energy are possible (and so far progress has been much slower than hoped), then we will have wasted tens of billions of pounds in the UK alone.

We should support research into alternatives to fossil fuels (and other useful technology, such as geo-engineering techniques to limit catastrophic climate change) directly instead of by creating an expensive artificial market.

Of course, we already support new technology with the patent system. If someone invented a cheap alternative to oil as a motor fuel, they would make a fortune. However, I think that there is a pro-active role for governments, or at least for philanthropy.

This could be done by funding universities and other researchers with simple grants. Not all of those grants will pay off, but the amounts of money at stake are relatively small. A better alternative would be to establish a series of well-calibrated prizes for technological developments that could substantially improve our ability to mitigate or adapt to climate change.

Prizes have a long history of success in encouraging productive research to address specific needs, whereas patents support

research in any area where there might be a market. They were effective in encouraging the development of new agricultural tools in the industrial revolution (Brunt et al. 2008) and in encouraging innovation in Meiji Japan (Nicholas 2013). The Longitude Prize in 1714 was a famous early example offered by the British government as a reward for the first person to develop a means to ascertain a ship's longitude. More recently, the X Prize led to the first manned private space flight. The X Prize was inspired by the earlier Orteig Prize, which saw $25,000 awarded for the first non-stop flight between New York and Paris. It is estimated that $400,000 was spent chasing that prize (White House 2011: 12).

Either way, the great thing about investments in R&D is that the costs are relatively small, in the tens of millions rather than the tens of billions, and you can therefore run lots of them. You can roll the dice many times and improve your chances. There are already a number of prizes relating to climate change. The Virgin Earth Challenge, for example, is a '$25 million prize for an environmentally sustainable and economically viable way to remove greenhouse gases from the atmosphere'. Other objectives for prizes should probably be more modest, but the idea has already been taken up.

There is no need for any international agreement. If we develop new technology that lowers the cost of cutting emissions or adapting to climate change, and other countries are then able to use it too, so much the better. Putting Britain's scientists and engineers to work developing new alternatives to fossil fuels for the future would be a much more effective contribution to reducing global emissions than deploying existing, inadequate alternatives now.

Conclusions

There is no sense in continuing to insist on a monolithic global attempt to ration greenhouse gas emissions. That approach has failed so far. Developing countries have not signed up. Developed

countries outside Europe have put economic growth before attempts to reduce emissions.

Yet European economies have so far made disappointing progress in decarbonising their economies. Its proponents always claim that the EU ETS is one reform away from functioning properly, but it is not. Renewable energy has proved so expensive that many member states have had to back away from extravagant subsidies, but they still face enormous bills. Green taxes are just an excuse to milk motorists.

Instead of trying to erect some kind of European memorial to the global deal never struck at Copenhagen, we should instead be thinking about a more realistic alternative. We need an approach in which policy can be adapted and changed as our understanding of the potential harms emerging from climate change evolves, and, just as importantly, we learn more about which technologies are the most promising, and which policy measures are the most effective.

Decarbonising modern industrial economies was always going to be difficult, and it is no indictment of politicians that they have made mistakes. The problem is that the mistakes are too large, the price is too high. In the face of enormous uncertainty, we should prefer solutions that can be adapted over time and allow us to roll lots of dice, improving the odds that some of them come up six.

There is an enormous opportunity to reduce the cost of climate policy. Energy markets could be rescued from their growing dysfunction. Rising pressure on family and business budgets could be eased. Industry could have a fairer chance to compete in international markets.

Whether or not you think this is possible within the EU, the key lesson is that good climate policy does not need the EU. The EU needs to show a new flexibility and accept a more modest, but more useful, role. Or this could be an area in which the UK could form better policy on its own.

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