TESTIMONY OF LORD NICHOLAS STERN

BEFORE THE

COMMITTEE ON ENERGY & COMMERCE
SUBCOMMITTEE ON ENERGY & AIR QUALITY

U.S. HOUSE OF REPRESENTATIVES

JUNE 26, 2008

Climate change: Costs of inaction, Targets for action

Chairman Boucher, Ranking Member Upton, distinguished members; I appreciate the opportunity to testify before the Energy & Air Quality Subcommittee of the House Committee on Energy & Commerce on the critical matter of the costs of doing nothing to stop climate change.

I am Nicholas Stern, IG Patel Professor of Economics and Government at the London School of Economics and Political Science. I was an adviser to the UK Government on the Economics of Climate Change and Development, reporting to the Prime Minister and the Chancellor of the Exchequer as Head of the *Stern Review on the Economics of Climate Change*. I was also previously Head of the Government Economic Service; Second Permanent Secretary to Her Majesty's Treasury; and also Director of Policy and Research for the Prime Minister's Commission for Africa.

Before entering Government Service I was World Bank Chief Economist and Senior Vice President, Development Economics. Before this, I was Chief Economist and Special Counsellor to the President European Bank for Reconstruction and Development.

My research and publications, of which there are more than 15 books and 100 articles, have focused on the economics of climate change, economic development and growth, economic theory, tax reform, public policy and the role of the state and economies in transition. The *Stern Review on the Economics of Climate Change* was published in October 2006.

Mr. Chairman, I request my statement on *Climate change: costs of inaction, targets for action* be entered into the record.

1. Risk

Greenhouse gas emissions (GHGs) represent the biggest market failure the world has seen. GHGs damage others and without policies we do not pay for that damage. We all produce them, people around the world are already suffering from past emissions, and current emissions have the potential to cause catastrophic damages in the future. These features, particularly the global nature of the link between emissions and damages, call for a global response. Failure to analyse the problem in terms of the great risks, the long term and global cooperation will, and has, produced approaches to policy which are misleading and dangerous. The arguments for strong and timely action are overwhelming. The costs of inaction, that is continuing with current paths and practices, or business-as-usual (BAU) should be measured in terms of the possible outcomes and damages relative to a path for the world that sets sensible targets.

The relationship between the stock of GHGs in the atmosphere and the resulting temperature increase is at the heart of any risk analysis: it is the clearest way to begin and anchors most of the discussion. There are many models that estimate these links: running a model many times for different parameter choices, yields probability distributions of outcomes – in other words allows us to take into account the uncertainty in the link between emissions and temperature changes.

Table 1: probabilities of exceeding a temperature increase at equilibrium (%)

Stabilisation Level (in ppm CO_2e)	3.6 F (2°C)	5.4 F (3°C)	7.2 F (4°C)	9 F (5°C)	10.8 F (6°C)	12.6 F (7°C)
450	78	18	3	1	0	0
500	96	44	11	3	1	0
550	99	69	24	7	2	1
650	100	94	58	24	9	4
750	100	99	82	47	22	9

Source: based on Stern Review box 8.1 (Stern, 2007, p. 220)

Current concentrations of GHGs are around 430ppm CO2 equivalent (CO2e – which aggregates carbon dioxide with other GHGs), and we are adding about 2.5ppm CO2e per year. This rate appears to be accelerating, particularly as a result of rapid growth of emissions in the developing world. There seems little doubt that, under BAU in the absence of any restraining policy, the annual increase in the overall quantity of GHGs would average somewhere above 3ppm CO2e, potentially 4ppm CO2e or more, over the next 100 years. That is likely to take us beyond 750ppm CO2e by the end of this century.

This level of concentration would give us, if we were to stabilize there by 2100, a 50-50 chance of a temperature increase over 9F (5°C). We do not really know what the world would look like at 9F (5°C) above pre-industrial times. The most recent warm period was around 3 million years ago when the world experienced temperatures 3.6F (2°C) or 5.4F (3°C) higher than today (Jansen et al., 2007, p.440). Humans (dating from around 100,000 years or so) have not experienced anything that high. Around 10-12,000 years ago, temperatures were around 9F (5°C) less than now and ice sheets came down to latitudes just north of London and just south of New York. As the ice melted and sea levels rose, and taking into account the changed topography, Britain separated from the continent and there was major re-routing of much of the global river flow. These magnitudes of temperature changes transform the planet.

At an increase of 9F (5^oC) most of the world's ice and snow would disappear, most likely including the Arctic and Antarctic ice sheets and the snows and glaciers of the Himalayas. The former effect would, taking the two ice sheets together, eventually lead to sea-level rises of over 10 metres, possibly much higher. The latter would thoroughly disrupt the flows of the major rivers from the Himalayas, which serve countries comprising around half of the world's population. There would be severe torrents in the rainy season and dry rivers in the dry season. The world would probably lose more than half its species. The intensity of storms, floods and droughts is likely to be much higher than present. Further tipping points could be passed, which together with accentuated positive feedbacks could lead to further temperature increase. The last time the temperature was in the region of 9F (5^oC) above pre-industrial times was in the Eocene period around 35-55 million years ago. Much of the world was covered by swampy forests and there were alligators near the North Pole. The point is not particularly about alligators, it is about transformation of the world: these kinds of changes would bring very radical changes to where and how different types of species, including humans, could live. Many of the changes would take place over 100 or 200 years rather than thousands or millions of years.

Whilst we cannot be precise about the magnitude of the effects associated with temperature increases of such size, it does seem reasonable to suppose that they would be, or at least likely to be, disastrous. They would probably involve very large movements of population from regions where human life would become extremely difficult or impossible. History tells us that large movements of population are likely to bring major conflict and this potential movement would probably be on a huge scale.

The cost of inaction is the high probability of these devastating impacts and conflicts. As Table 1 shows, we can cut the probability of being above 9F (5^{o}C) from 50% to 3% by stabilizing at 500ppm CO2e. We cannot be very precise about these probabilities and the ones we have used here, from the Hadley Centre, are probably cautious. The point, however, is that the reduction in risk is huge. There are corresponding reductions for 7.2F (4^{o}C) and 10.8F (6^{o}C) and other temperatures (see table). We focus on 9F (5^{o}C) to make the point as simply as possible.

By using extremely simple models one can try to quantify the avoided dangers although our description of the avoided risks should make it clear that it is very hard to attach convincing numbers to the potential losses. Even from a very narrow perspective, world wars seem to involve losses of 15% or more of GDP and the conflicts we are discussing are likely to be on a bigger scale, longer lasting and, of course, affect much more than GDP. The Stern Review, which looks at damages up to 2200 and extrapolated thereafter, concluded that such costs can be estimated as being equivalent to a 5-20% loss in the range of the world GDP averaged over space, time and possible outcomes. Such models can provide useful insights but we warned strongly against taking them too literally

A recent report by Frank Ackerman and Elizabeth Stanton at Tufts looks specifically at the effect of uncurbed emissions in the US. By 2100 the increase in temperatures would be between 5.4-9F (3-5^{o}C) – this would make temperatures in Anchorage, AK similar to today's temperature New York City, but that is not really the main point. The effects of climate transformation are largely through water in some shape or form. The effects of hurricanes, destruction of residential real estate, changes in the energy and water infrastructure would, according to the authors, cost the US around $2 trillion. The overall cost of BAU at 2100 would be greater, particularly taking into account the impact of the effects of changes in the rest of the world to the US. The overall cost, using a methodology similar to the one adopted in the Stern Review, would be equivalent to a 3.6% loss of the US GDP in 2100. We should emphasise, however, that there are many likely, larger, and deeply damaging, effects which will occur after 2100 and these calculations take no account of the effects on the USA of the damages and devastation which occur outside the USA.

2. Recent developments on risk and damages of climate change

There are a number of factors which climate change scientists and economists have raised recently which point to a worsening of the prospects on climate risk.

First, recent data – particularly from developing countries – indicates that emissions are growing more quickly than we thought. For example, a recent study by Max Auffhammer, UC Berkeley, and Richard Carson, UC San Diego, indicates that carbon emissions in China, over the 2004-2010 periods, are growing at 11% p.a... BAU assumptions used by the IPCC projected a growth of only 2.5-5% p.a. At this pace by

2010 China would have increased its carbon emissions from 2000 by around 600 million metric tons. To put in another way, the projected annual increase in China alone over the next several years is greater than the current emissions produced by Germany. If indeed emissions are growing more quickly than we thought, then the dangerous CO_2e concentration levels, associated with higher probabilities of disastrous temperature increases, will be reached much more quickly.

Second, the key feedbacks of the carbon cycle, such as the reduction in the absorptive capacity of the oceans, and thus the reduced effectiveness of a key carbon sink, and the release of methane from the permafrost, have not been taken into consideration in the projected concentrations increases quoted here. It is likely that, if these factors were accounted for, stabilizing at stocks associated with lower probabilities of disastrous temperature increases could be even harder.

Third, it is increasingly clear that we know little about what would happen in the world if we were to see very high concentrations of GHGs: indeed given the nature of feedback mechanisms, scientists agree that damages associated with very high GHG concentrations could be enormous. Most of the current research on damages makes conservative assumptions about such ‘extreme events’. As the Harvard economist Martin Weitzman, among others, has convincingly shown in his research, taking such extreme events into consideration escalates the impact of climate change – and its potential cost to the economy.

In light of such evidence, it is likely that the balance of the evidence implies that the risk in the IPCC 4th Assessment Report and the Stern Review may be underestimated.

Therefore the opinion, which some commentators expressed, that the Stern Review was alarmist, is simply wrong.

3. Discount rates and damages

Let me, lastly, touch upon an important and much misunderstood issue: discounting. This debate is inevitable in the context of climate change, as it relates to how to evaluate damages that will burden future generations. The basic question here is how economic analysis should account for the fact that actions taken today will affect later generations. If we do nothing now, we will be shifting significant costs to the future. Economists use discounting to evaluate future costs and benefits, making it an essential tool to carry out such analysis. The popular press, and more than one professional economist, have misunderstood this issue. Earlier this year I was invited to give a lecture in honour of Richard Ely, the founder of the American Economic Association (AEA), during the Area's Annual Meeting. It is the principal invited lecture of the main gathering of professional economists in the world. This lecture, which has now been published in the American Economic Review, carefully sets out the theoretical basis for the approach to inter-temporal judgements and discounting, including that used in the Stern Review. To summarise, in this paper I show how in the Review we discount impacts for the right reasons – that we are (we hope – although climate change could destroy this) likely to be substantially wealthier in the future, so the value of an extra dollar then is likely to be lower than the value of an extra dollar now.

What the Review does not do is go further and discount future generations additionally, purely on the basis of birthdates; this is called pure time discounting. Discounting the future simply because it is the future is to adopt the value judgment that we should *a priori* care less about future lives. Many would find this unacceptable: for example, to have a pure time discount rate of 2% means attaching half of the weight to someone born in 2005 relative to someone born in 1970, assuming they have the same lifetime pattern of consumption. Those who advocate for such an extreme approach should provide a convincing argument. They do not. Many philosophers, and indeed many economists (including Ramsey (1928, p.543), Pigou (1932, pp.24-5), Harrod (1948, pp.37-40), Solow (1974, p.9), Mirrlees (Mirrlees and Stern, 1972) and Sen (Anand and Sen, 2000)), believe this to be arbitrary, and providing no serious ethical basis for long-term public policy choices. Reasonable people may differ on ethical positions but this type of heavy discounting of lives requires justification. The approach of treating people with different birthdays in an equal way is a direct invocation of a notion of equality that is standard in most treatments of justice and rights.

Furthermore, it is not possible to read off inter-temporal ethics for this type of decision from the behaviour of markets. We cannot see a collective expression in the markets of what, acting together, we should do for ourselves and our descendants over the 100 or 150 years. Current market interest rates tell us only about individuals' willingness to invest, lend or borrow today for benefits in the relatively near term. How society should treat young or unborn generations is a different question. Neither can we say that we should invest in something else and pay to deal with the damage from climate change later. This makes the mistake of ignoring relative price changes:

the rate of accumulation of GHG emissions and the potential irreversibility of environmental damages imply that the price of later action (when GHG concentrations will be higher and the environment damaged) will be much higher. In summary my own view is that much, although not all, of the discussion on discounting has been in ignorance or in dismissal of the right tools of analysis for a problem which involves non-marginal changes, major risk and imperfect markets. There is no substitute for an analysis which takes these issues seriously and for engaging in direct ethical discussion.

The latest evidence on the science which I mentioned earlier, however, has an interesting implication: even if we were to use much higher discounting the higher risk of severe damages would imply that the overall numbers on cost do not change significantly from the original results of the Stern Review.

4. Conclusions

To conclude, it is dangerous, in my view, to advocate weak policy and procrastination and delay under the banner 'more research to do' or 'let's wait and see'. The former argument is always true but we have the urgent challenge of giving good advice now, based on what we currently understand. The latter is misguided – waiting will take us into territory which we can now see is probably very dangerous and from which it will be very difficult to reverse. The same is true of policies which speak of a 'slow ramp'. If we conclude that, whatever the merits of the argument, it is too difficult and costly to implement the policy of strong and timely action, then we should at least be clear about taking the responsibility for the great risks of moving to the very high

GHG concentrations and resultant damages which are likely consequences of no, weak, or delayed action.

The common sense analysis of risk is clear. If we assume the science is right, and act correspondingly, and it turns out to be wrong, we will have some new technologies and a cleaner and safer world. If we assume the science is wrong and delay action and it turns out to be right, then we will be unable, except at a very high cost, to back out.

Our analysis of climate change risk, and the associated economic risk of damages, points to identifying a target which reduces the risk of exceeding dangerous temperature changes: taking on a stock target of around 500ppm CO_2e would reduce the probability of exceeding temperatures higher than 5.4F (3^{o}C) to about 50-50, the absolute minimum we should aim for. Many would argue that a 50-50 risk of a 5.4F (3^{o}C) increase is too dangerous. This target, and the corresponding path of emissions, is compatible with roughly halving all GHG emissions by 2050, with respect to 1990. We estimate that the cost of action of stabilising at around 500ppm CO_2e is manageable, in the range of 1-2% of global GDP in 2050. Similar results have emerged from recent research by the IPCC (Edenhofer et al. 2006), McKinsey and Company (2007), and the International Energy Agency among others.

This is the kind of judgement that people take when considering various forms of insurance, or design of buildings or infrastructure, or new medical treatments. They try to be as clear as possible on consequences and costs, bearing in mind that both are uncertain and that risk is of the essence, whilst also being aware that it will often be difficult to put a price or money values on consequences and risks.

The target to halve emissions by 2050, which is also what world leaders have agreed at the G8 meeting at Heiligendamm in June 2007, is compatible with such a judgement call. If we decide to halve our GHG emissions by 2050 from the 1990 benchmark, then the world must to go from around 40GT CO2e in 2000 (which was only a little about 1998) to roughly 20GT CO2e in 2050. World population, by 2050, is projected to be around nine billion, which brings us to a world average target of around 2T per capita.

For all countries to reach such per capita levels requires early and concerted action. Most developed countries (including Japan and most of Europe) emit around 10-12T CO2e per capita, with a cluster (including the USA) in the range 20-25T. These economies would therefore need to cut per capita emissions by at least 80% by 2050; for the latter cluster the reductions would have to be 90%. By contrast, developing world per capita reductions are generally lower. The average per capita emissions in China is currently around 5T, and in India approaching 2T, and these are set to grow rapidly. By 2050, out of a total global population of nine billion, some eight billion will reside in what is currently the developing world. These numbers make clear that a reduction in global emissions of 50% relative to 1990 levels by 2050 simply cannot be achieved without per-capita emissions in developing countries averaging around 2T.

A target of 2T per capita emissions by mid-century is so low that there is little scope for any major group to depart significantly above or below it. If one or two large countries, developed or undeveloped, were to manage only to reduce emissions to, say, 3T or 4T per capita, then it would be difficult to see which other major grouping of countries would be able to get emissions close to zero: and the global target would be unlikely to be reached. Thus, as a matter of pure arithmetic, all countries must play their part in aiming for around 2T per-capita emissions by the middle of the century and all emissions trajectories should be designed with this target in mind.

All major groups getting to 2T per capita is a pragmatic approach to cutting emissions by 50% by 2050 and not a strongly equitable one. It takes little account of the greater per capita contributions of the developed countries to the historical and future contributions to the stock of GHG emissions. This is particularly true for fast growing economies, such as China: per capita emissions in China are currently at 5T per capita, well above 2T per capita and are projected to increase very quickly over the next decade. A target of 2T per capita by 2050 would, therefore, put substantial pressure on these countries to contain and reduce their emissions during a period of rapid growth. Modelling the cost of mitigation, based on the pan-European Poles model, indicate that the cost to China of such a target would for the year 2030 be approximately 3% of GDP. If the 'industrialisation party' started in 1850 then we are asking everyone to drink out of the same size glass 200 years later notwithstanding all the drinking out of our shared well – the atmosphere – which took place before. That is a weak notion of equity.

Given the substantial effort that developing countries will need to make to reach the 2T per capita, the 80% reduction in GHG emissions necessary in developed countries is, therefore, not only a matter of arithmetic. It is a necessary step for the developing countries to take part in this global effort. They cannot halt their drive for development, but we know that high carbon growth across the world will make climate stability and climate security unachievable. The answer must be low carbon growth, not low growth. High carbon growth will eventually undermine growth itself – it is not a medium- or long-term growth option.

To achieve low-carbon growth, developing countries look to the rich world as originators of the bulk of the stock of GHGs and as holding the resources and the technologies. To be in a position to take on their own targets, they will need to see progress on the following four elements:

(i) Developed countries taking on ambitious targets immediately;

(ii) Demonstration that low-carbon economic growth is possible;

(iii) Substantial financial flows to countries with cheap opportunities to abate GHGs; and

(iv) Low-carbon technologies available and shared, allowing developing countries to innovate, develop, and ultimately export their own low-GHG technologies.

Thus, conditional on progress on these elements, it is reasonable to ask them to commit now to commit explicitly by 2020 to targets consistent with 2T per capita in 2050 and to put together credible plans between now and then to get onto such a path. And let us be clear that their transition will not be easy: they require strong collaboration and support in making this change as they seek to overcome poverty.

There is a key point here about carbon trading: the desired outcome is not achievable without a global market able to mobilize the scale of financial flows necessary to implement the low-carbon technologies where they can be developed and deployed most cheaply. The details of such markets are of great importance, and will be an important part of the global deal ahead.

The challenge is far-reaching, comprehensive and global, but it is manageable. The technological transformations and flows of funds required across countries and sectors will be large, the institutional and implementation challenges significant, but the costs of action are affordable and entirely consistent with sustainable growth and development. By contrast, the alternative of inaction or delay is not. Low-carbon growth is the only growth option. High-carbon growth will eventually undermine the prospects for all. The world is looking at the US to take the lead, the future of the global deal is in your hands.