The Economics of climate change

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The scientific fact of climate change is now largely accepted: the percentage of respected climate scientists who deny that global warming is occurring and is man-made is now minute. And that reflects the compelling evidence. We know that the concentration of greenhouse gases in the atmosphere [Slide 1] – which over half million year until the start of the industrial revolution oscillated in a range between 180 and 300 parts per million – has now reached 440 and is increasing at about 2 parts per year. We know that even if we do take action now to reduce emissions, it will be extremely difficult to stabilize concentrations below, say, 550 parts, i.e. below twice the pre-industrial level.

And we know that greenhouse gases warm the earth – the correlation of greenhouse gas concentration and temperature over the last half million years startlingly clear on this slide. [Slide 1] So we are conducting an enormous chemical experiment which is almost certain to raise the earth's temperature significantly, and that temperature increase is already occurring.

The key question therefore is no longer – is global warming occurring, but what are we going to do about it. And since the causes of the warming are economic – the progress of material prosperity – so must the solutions be built on sound economics.

So the topic this evening is the economics of climate change. But in talking to that topic I obviously have a disadvantage – I am not Nick Stern. Nick has written a superb Review, combining detailed analysis of economic theory with balanced judgments on the right way forward. I could just put up some summary slides of his conclusions, and urge you to read the book.

But the Stern Review has not put an end to the debate. Some eminent economists have questioned some of the Review's assumptions and some rather less eminent ones have attacked it roundly. And those attacks have received significant publicity. A prominent OP Ed piece in the Daily Telegraph [Slide 2] warned of another "dodgy dossier", as alarmist and unfounded as the one on Iraqi weapons of mass destruction. And alongside the intellectual counterattack, the more mundane process of special interest lobbying continues. Angela Merkel's speech to the Davos World Economic Forum two weeks ago promised that Germany would provide leadership on climate change in the G8 and European Union, but that hasn't stopped German car manufacturers arguing

against tighter European auto emission standards. The economic case for significant and early action on climate will have to be continually made.

So tonight I'm going to focus on two sets of arguments which economists have presented against early action on climate change.

- First, the criticisms of the Stern report
- Second, the case presented in the Copenhagen Consensus project, organized by Bjorn Lomborg.

Together these arguments make the following case – even if the majority view of climate change scientists, expressed in the IPCC reports, is correct, sound economics suggests that we should take action later rather than sooner, and sound ethics suggests spending our money on more pressing problems such as Aids, malaria or malnutrition. It is these assertions I'll assess tonight. And in doing so comment on the role that good economics – the not so dismal science – should play in our decision-making.

Stern's overall conclusion is that [Slide 3] "I*f we do not act, the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year now and forever. If a wider range of risks and impacts is taken into account, the estimate of damage could rise to 20% of GDP or more. While in contrast the costs of action – reducing greenhouse gas emissions to avoid the worst impact of climate change – can be limited to around 1% of global GDP each year".*

It is this summary assessment which has unleashed controversy in the economics profession. Professor William Nordhaus has accused Stern of failing to present a balanced picture; Professor Partha Dasgupta believes that "*parameter values have been chosen to yield desired results."*[1] While Professor Richard Tol, though quoted approvingly by Stern at several points in his Review, has attacked the report as alarmist and incompetent, though with so intemperate a tone and such stunning internal inconsistency that it is difficult to consider his comments as a serious contribution to the debate.[2] Seminars are being held, commentaries

[1] See "*The Stern Review of Economics and Climate Change", William Nordlhaus,* November 17th, 2006, and *"Comments on the Stern Review's Economics of Climate Change"*, Sir Partha Dasgupta, November 11th 2006.
[2] See *"The Stern Review of Economics of Climate Change: A Comment",* Richard Tol, November 2006, and interview with Richard Tol for *WirtschaftWoche*, November 11th 2006. In the latter

written and posted on the Internet, and the deadliest weapons in the academic armoury, the footnote and the rebuttal of others' footnotes, have been extensively deployed.

Despite the noise of battle, however, the debate is essentially one about degree rather than principle. All the economists involved accept that climate change is occurring and could have harmful effects.All accept that emissions should sometime be cut. Nordhaus for instance talks about a "ramp up" of climate change policy with "modest reductions in the near term, followed by sharp reductions in the medium and long term." But though the differences are of degree rather than principle, they are still profound. While Stern believes we should cut emissions by something like 90% versus business as usual by 2100, Nordhaus suggests optimal cuts of only 25%.

In principle, the key question to which climate change economics should provide the answer is clear. [Slide 4] We want to compare, the economic and social costs of climate change, the costs of mitigating climate change, and the costs of adapting to climate change. And we wish to compare alternative future emission parts, to find the one which maximizes the net present value of human welfare, given the changing pattern of costs through time and using appropriate discount rates to compare the value of different people's welfare at different points in time.

In principle simple, but in practice a mind-bogglingly difficult calculation, and one which, as we shall see, requires not only computational complexity, but conceptual difficulty and inherently subjective judgments.

But the complexity and subjectivity relate almost entirely to the costs of adverse consequences and of adaptation – much less to the costs of mitigation. For the striking agreed fact in the complex economics of climate change is that the costs of mitigation are surprisingly small.

The Stern Review investigated the possible costs of a policy designed to limit concentrations of all greenhouse gases to a maximum of abut 550 p.p.m, of CO^2

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interview, Tol claims that "Stern has set the cost of emissions reduction much too low", but then says "worldwide greenhouse gas emission could be halved in one fell swoop if the world would employ the best available technologies". He attacks Stern's description of environmental damage from climate change as "alarmist" but says that if the Chinese don't pursue climate change mitigation plans within a decade, "they will be threatened by catastrophic environmental damage".

equivalent. That would probably still imply a temperature increase of about 3ºC above pre-industrial levels, but would greatly reduce the risk of significant higher increases. It would require [Slide 5] that emissions were set on something like this trajectory, peaking around 2020 – 2025, down 25% against today's global level by 2050, and eventually down 80% below present levels and even more against business-as-usual. Given the inevitable growth of per capita emissions in China and India towards developed country levels, this would require rich countries like the UK to cut emissions by something like 60% from current levels by 2050. But the Stern Review's best estimate of the global cost of this path is about 1% of GDP, and previous estimates for the UK suggest that the cost of cutting our emissions by 60% by 2050 could be between 0.3 – 2.0% of GDP in that year, say 1% as a mid-point estimate.[3]

Which would mean that [Slide 6] rather than UK GDP growing at, say, 2% per annum from now to 2050, it might grow at, say, [Slide 6A] 1.98% - opening up the huge gap in prosperity you see on this chart – or maybe don't see at the back of the hall, given that the lines are so close as to be virtually indistinguishable. GDP per capita in 2050 just a 1% or so below what it would otherwise be. Prosperity reaching in about July 2050 the level it would otherwise have reached in January, a level over two times the current.

And the estimates for the US are of a similar magnitude. Which doesn't exactly sound like a threat to the American way of life. And what's interesting is that while within the economic profession there's a lively debate about whether we should accept even these small costs – there is close to unanimity that the costs of achieving emission cuts are this small.

Why that unanimity? Cutting carbon emissions can be achieved in many different ways. Some of these involve no adverse impact on economic growth – some might have adverse impact, but only quite a small one. And the range of estimated costs, from a fraction of 1% to a few percentage points, reflects the fact that we don't know what mix of zero cost and small cost actions will result. But we do know that whatever the mix, the maximum cost cannot be large, because even the most costly actions are not all that costly.

Think about three ways of cutting carbon emissions [Slide 7] – changes in lifestyle, improvements in energy efficiency, and deriving our energy from non carbon emitting sources.

[3] "*Options for a Low Carbon Future",* DTI June 2003

The first category – minor changes in lifestyle – involves no cost to GDP at all. If people can be persuaded to buy more fuel efficient autos what happens is that they spend less money on autos, and have more to spend on other less carbon emitting forms of consumption – while GDP and GDP growth doesn't change by one penny. And if they are persuaded to do that by increased taxation on petrol, offset by lower taxes on some other consumption items – GDP growth doesn't change one penny. If American air conditioning was set 1 or 2 degrees higher, and people spent the money saved on other categories of consumption, America GDP growth would not fall one cent: and there would be a lot of happier foreign visitors, no longer bewildered by the idea that you should spend money to send such a blast of cold air down on someone that they need to dress more warmly in an office in Atlanta in the summer than they would dream of dressing in their office in London in winter. In rich developed societies we face multiple opportunities to adapt our behavior in ways which cut emissions significantly, but which make only very minor difference to our overall lifestyle.

We are also faced with numerous opportunities – in households and in companies – to use more energy efficient technologies in ways which cost us nothing and which don't even require <u>any</u> changes in end life style.

Setting the air conditioning a degree warmer requires a very minor adjustment in end life style – a slightly warmer environment – but using this light bulb not this light bulb – changes life style not at all, because they both produce the same amount of light, but this one is an 12 watt bulb, this one an 60 watt bulb – an 80% cut in emissions for the same end benefit. And if you buy this light bulb over a five year period the light bulbs and the electricity used cost you 10% less than if you use this light bulb, so that your material prosperity – measured in your ability to spend more money on other items of consumption – goes up. Household face many such opportunities, and throughout the economy companies too are sitting on huge opportunities to save energy through the redesign of processes in ways which simultaneously cut emissions and give positive returns, if only they make energy saving a key focus of management attention. In the UK, work by the Carbon Trust suggests that Britain could cut carbon emissions by at least 10% in ways which far from costing money, actually save money, and which therefore far from cutting the growth rate, would increase it.

So by minor changes in life style and through energy efficiency improvement, we can go a long way to cut emissions at minimal or indeed nil economic cost, and

to cut emissions even if our energy comes from the same mix of sources as today. But the third category of change is to change the energy source – either to renewable sources, wind power, solar, bio-fuels – or to fossil fuels used in a non carbon emitting fashion, capturing the CO^2 at the power station outlet and storing it by injecting it into geological structures, carbon capture and storage. And it's this third route which is most likely to result in some cut to GDP, because low carbon energy sources are likely to be more expensive than carbon emitting sources. But not that much more expensive, and in some cases no more expensive at all.

At current oil, coal and gas prices, and certainly at the gas prices we lived with a year ago, onshore wind farms are in the UK close to competitive with fossil fuels as a source of electricity – they hardly need a subsidy. And we can probably get up to 20% of our electricity from wind at minimal cost to GDP. Bio-fuels – bio-diesel and bio-ethanol – are still more expensive than fossil fuel based diesel or gasoline, but at present oil prices, they are something like 10-50% more expensive, not twice or three times as much. Solar photovoltaic energy is currently much more expensive than fossil fuel based electricity, but much more expensive means 3 to 4 times more expensive, not 10 times more expensive, and that 3 – 4 times will come down.

So that the reason why economists are close to unanimous that the total cost of radical emission cuts will be at most only a few percentage points of GDP, is the following simple but robust mathematical logic.

A developed rich economy – such as Britain or America – spends about 4-5% of its GDP on energy inputs. By 2050 that percentage will probably be only about 2-3%, simply because even under business as usual, we steadily improve the energy efficiency of our economy. So suppose that in order to reduce CO^2 emission by 60% we will have to pay 50% more for all our energy than we do today, then the economic cost of doing that will be 50% of 2 - 3%, which is 1 - 1.5%.

Sometimes the crucial economic insights do not rely on complex models or complex theory, but on order of magnitude calculations and common sense. The total cost of radically reducing our emissions will depend on the mix of the different types of action by which we reduce emissions – but even in the worst case is going to be only a few percentage of GDP, a delay of 1 year, say, in getting to the date at which we have increased our material standard of living 2 and a half times.

So whatever the debate about whether we should cut emissions and how fast, the fact that it is possible over a fifty year time frame to cut them radically at low cost is absolutely clear.

But while as a percentage of GDP these costs are small, in absolute terms they are large – 1% of world GDP is about $500bn.

So it would not make sense to accept these manageable costs unless the adverse consequences of climate change were larger. The problem of climate change economics is that when we turn from mitigation costs to the cost of adverse consequences, agreement collapses, and complexity explodes.

Stern may say that the adverse consequences could be equivalent to 20% of GDP lost now and forever, but Richard Tol can produce figures as low as 0.5% - 2%. And Stern himself presents not a single estimate, but a wide range – the best judgement lies somewhere between 5% and 20%; but 1% is possible but so too is 35%.

Why this huge range, and what, if anything, can economics tell us, if it cannot pin down the facts more precisely than 1- 35%?

The problem is that calculating and aggregating the costs of adverse consequences involves at least four layers of complexity.

[Slide 8] First that we need to consider not only direct market economy impacts, but also non-market impacts. Working out the economic value of possible changes in agricultural yields or the cost of sea defenses or of losses from extreme weather events, is computationally complex and involves uncertain estimates, but at least these are effects which do directly impact measured GDP. But climate change will likely also create increased deaths from heat waves (as well as fewer deaths from cold snaps), it will encourage the spread of tropical diseases, and it will flood some coastal areas and lead to movement of people. And while economics has developed techniques for estimating the value placed on a human life, or on human health, those estimates are highly imperfect and inherently judgmental. And climate change might produce socially contingent effects – creeping desertification producing movement of people, which in turn produces political instability, which in turn undermines economic progress and quality of life. But try putting a precise value on that danger. And climate change can impose costs which are in essence entirely subjective, but which are

also part of the calculus of human welfare. Personally I value the diversity of nature as an end in itself: if climate change leads to habitat loss which leads to the disappearance of major species, I would regret that, and the fact that people give large amounts of money to environmental charities suggests that many other people share the same preference – it is in economist parlance a "revealed preference". So the preservation of the environment and of species as an end in itself should be given some value in the calculation. But how much?

So there is a major problem in aggregating direct economic effects – which influence measured GDP and material consumption, with non-market effects on health, on social stability or on the environment itself.

But even if you can do that, for each country considered alone there is a second aggregation problem: how to add together the welfare of different people, rich and poor? Because the way economists typically place a dollar equivalent on human health effects – is to ask how much income people would logically and do actually sacrifice to preserve life and health, and the answer is of course bigger in richer countries. But that technique, useful within a country to assess the cost effectiveness of different policies – is surely unethical if it implies that a human life in Niger should count for less in climate change policy than one in America. So we need to adjust our technique to make weigh human welfare equally, but that's a pretty complex thing to do.

Two further complexities must also be faced. [Slide 9] The first is that the harm caused by climate change is likely to be strongly nonlinear, that 4°C warming is likely to be much more harmful than 2° centigrade. But it is unclear how much more harmful, and whether you can capture that non-linearity in a mathematical function, such as $y = x^2$ or $y = x^3$, or whether we face a unique non-regular shape, with damage increasing dramatically once some threshold is reached.

But with it unclear whether any given concentration level will take us beyond such thresholds, [Slide 10] since the science too provides us not with certainties – 550 parts per million will equal a rise of 3°C , but instead with probability distributions, such as it might be 3°C but there's a 10% chance it could be 5°C. We therefore need to build our aggregate calculations on probability distributions of possible results, and to place a subjective value on uncertainty – how much should we pay for excluding the 10% possibility of severely adverse affects, or the 1% possibility of catastrophe, if the most likely result is only moderately adverse.

This cumulative complexity explains the wide range of results. And it creates a big challenge for climate change economics – that if we stick to the clearly measurable adverse consequences, avoiding conceptual complexity, we systematically underestimate the consequences for human welfare. One key reason why Stern's estimates are higher than others' is simply that he has attempted, however imperfectly, to deal with all the complexities – or at least nearly all – since even his figures make no allowance for socially contingent effects.

And this cumulative complexity also carries implications for the role which aggregate estimates of damage should play in the debate – useful only as indicators of orders of magnitude, and as double checks to supplement the more straightforward approach, which is to look at the different adverse consequences separately and descriptively – what impact on agricultural yield, what possible consequences for human health, what impact on potentially displaced communities, what loss of biodiversity and what impact separately on rich and poor – and to reach a judgment, essentially subjective, on how much you would be willing to pay to at least mitigate those adverse effects. There is no black box calculator which can free us of the responsibility to make ethical judgments.

But in so far as the aggregate figures tell us anything, we should take from them four key messages.

- First, that there is a huge range of uncertainty, but that uncertainty is an argument in favour of action, in favour of taking out an insurance, not an argument against.
- Second, that almost all the models indicate much higher costs to human welfare in poorer developing countries than in rich developed ones, simply because the poorer countries are concentrated in already warmer parts of the world, and are vulnerable precisely because they are poor.
- Third, that the models suggest that adverse consequences will probably increase rapidly as we go beyond thresholds of something like 3ºC above pre-industrial levels.
- Fourth, that inevitably judgemental but still reasonable assumptions can produce estimates of total damage far higher than our much more certain estimates of the cost of mitigation.

These four conclusions establish a strong case for action, and in particular for action which seeks to limit the chances that future temperature rises will go above some modest threshold.

But that is not the conclusion you will reach, even if you do attempt to capture all consequences for human welfare, if when you come to comparing sacrifices today with benefits in the future you use a high discount rate. Choice of discount rate alone indeed is likely to explain about half the difference between Nordhaus's estimate of an optimal 25% emissions cut versus business-as-usual in 2100 and Stern's proposed 90% cut. [Slide 11][4]

With a 4% discount rate £1000 in 150 years time is worth only £3.66 today; with a 2% discount rate, £59; with a 4% discount rate and 2% growth you wouldn't even sacrifice 1% of GDP today to save 15% of GDP in 150 years time: the loss would need to be 16.1% or more to make the sacrifice sensible. With a 2% discount rate and 2% growth, saving only 1% of GDP in 150 years time would be worth sacrificing 1% today. But the discipline of economics provides no definitive resolution of what the discount rate should be, but instead two quite different approaches and many possible answers. [Slide 12]

Professor Nordhaus's approach is often called the descriptive – you derive your estimate of the discount rate from observing the rates of return actually achieved on productive investments across the whole economy, a figure which economists tend to estimate at about 4-5%. The argument for this approach is two fold.

- First, that if you are considering sacrificing consumption today to achieve reduced emissions for the benefit of the future – you should consider also the alternative of taking the foregone consumption, investing it in productive assets and increasing future GDP in a way which will compensate for future climate change effects.
- Second, that the actual rate of return in the marketplace tells us about people's preferences between consumption now and in the future, and it's

[4] In Nordhaus op. cit. November 2006, Nordhaus illustrates that if Stern's discount rate is applied to Nordhaus's DICE model, with no other assumptions changed, the optimal price of carbon in 2005 rises from $17.12 per ton to $159, versus the $311 per ton (Nordhaus's figure) implied by Stern's analysis. Thus half the difference is explained by the discount rate alone; this is likely to be true also of optimal emission cut calculations, but detailed modelling would be required to identify precisely what proportion of the difference is explained by the discount rate alone.

not the job of economists to tell people how they should make that trade-off but to explore the consequences of their revealed preference.

By contrast, Stern's approach and also Dasgupta's entails deriving discount rates from a priori logic and from ethics. [Slide 13] In this approach the discount rate is given by the formula *R = eta* times the growth rate plus *delta*, where these terms have the following meaning. Eta is a factor known as the elasticity of the marginal utility of consumption. It determines how the value we place on an extra unit of consumption or welfare should vary with the level of consumption or welfare already achieved. All economists pretty much believe that there is a declining marginal utility of consumption, that an extra £ is worth less to a rich person than a poor person; the question is how much more. The factor eta is a measure of how much more – how curved is that line relating welfare to consumption, how rapidly the marginal benefit of extra income declines as income itself rises – whether between people in the same generation, or between people in this generation and the next. Stern assumes a base case value of 1.0, which is a value with the implication that while a £ in 2100 will be worth less than a £ today provided the economy has grown, 1% of GDP in 2100 is worth exactly the same as 1% of GDP today. Dasgupta agrees with the approach but believes that the specific eta Stern uses as his base case places too much value on the marginal prosperity of richer people, that the curve should curve more, flatten out more.

g is the growth rate in GDP after adjusting for the adverse effects of climate change – so that if those adverse effects <u>were</u> big enough to drive human welfare down, the discount rate would turn negative.

Delta meanwhile measures how much more we should value consumption today rather than consumption in the future, not because future people are likely to be richer than us, but simply because we who are making the decision care more about ourselves than about people in the future. Stern argues that it is ethically unacceptable to set this at other than a very low level: he uses a 0.1% base case. In total, with an illustrative growth rate of 1.9%, a discount rate of 2.0% results, well below Nordhaus's 4%. And from that difference flows much of the difference between Nordhaus's 25% cut in 2100 and Stern's 90%.

How to decide between these different approaches? I believe,along with Nick Stern, that there are compelling reasons for following the prescriptive approach, but that Dasgupta's argument for different parameters, a slightly higher eta, has

some power. But Stern's sensitivities illustrate that significantly changed parameters do not change his overall conclusion.

First the descriptive approach. [Slide 14] Its first argument was that if the rate of return on investment is 4% today, and if you want to help offset climate change consequences in 2100 by sacrificing some consumption today, you have the option of investing in a sort of "fund for future climate change offsets" investing foregone consumption in productive assets, rather than accepting lower GDP to achieve emission reductions. But this argument is surely flawed on two grounds: first, the impossibility of being certain that the proceeds of this hypothetical fund would actually be used to compensate future climate change losers, second the fact that we don't know what the rate of return will be beyond the near term future, and that, as Stern argues, it is itself a function of future growth, after allowing for climate change effects. Defenders of the descriptive approach therefore have to move on to their second argument, accepting that the discount rate should be determined by a formula, with input parameters eta and delta, but arguing that the value of eta and delta should be set so as to be compatible with actual observed rates of return, since those observed rates tell us about actual revealed preferences. If the observed rate of return is 4% and the growth rate about 2%, an eta of 1.5 and a delta of 1% would be possible, but Stern's proposed values would not. So people's revealed preferences suggest that people actually care less about the future than Stern suggests they should. But the arguments against this approach are also I believe compelling. Individuals may within their own lifetime be either rationally or irrationally impatient – they may prefer consumption today simply because they might die early or because they myopically do not think about the future, and their own savings decisions and therefore rates of return within the economy will reflect this impatience. But neither their rational nor irrational impatience is an ethically acceptable basis on which to determine the discount rate between the present and future generations. The more we care about the welfare of future generations, the more we should take climate change actions today. Sound economics doesn't free us from that ethical choice.

Even accepting that, however, it is possible to sympathize with Dasgupta's argument for a somewhat higher eta than Stern's base case. For as Dasgupta stresses a good test of a sensible parameter value is it that produces results which feel intuitively right. And with an eta of 1.0 you can construct some propositions which don't necessarily feel right, even to someone who believes we should take action to mitigate climate change. Thus for instance, suppose there were no climate change problem and no problem of countries being rich and

poor. And that in such a world the government proposed a plan to cut current consumption by 1% today to achieve a 1.11% increase in GDP 2100, making slightly richer still the people of 2100 who in any case will be far richer than we are today. Stern's eta of 1.0 and delta of 0.1% would say "do it", because 1.1% of GDP tomorrow is worth as much as 1% today.[5] But that is not a clearly compelling proposition. Set the eta higher, perhaps at the 1.5 which Dasgupta suggests, and you wouldn't make this trade-off, because you would attach less value to future increments in the prosperity of already richer future people.

And yet Stern's conclusion that we should act now to offset climate change damage later, does feel ethically compelling, even while that simple example I just used does not. And there are good reasons why that is the case – because what is proposed in climate change action is not a sacrifice of average consumption today to achieve increased average material consumption in 2100, but instead a more complex trade-off which makes the whole concept of one discount rate a huge simplification. [Slide 15]

For we are back with the problems encountered earlier – how to aggregate market and non-market effects and how to aggregate welfare effects across countries of widely different prosperity. If for instance we believe that the future is one of growing material consumption, but declining environmental quality, and that we value both separately, then the discount rate, whatever the eta, should be positive for consumption because it is worth less at the margin as it grows and negative for environmental quality because it's getting more precious as it declines. And we can only aggregate these together and use one discount rate if we are very confident about the relative weight we attach to those two divergent trends.

And the discount rate should also in principle vary according to who loses and who gains. If an average British citizen sacrifices consumption today for the benefit of a richer average Briton in 100 years time, the discount rate should clearly be positive and perhaps higher than Stern's eta of 1.0 implies. But if an average Briton sacrifices consumption today to benefit a poorer African in 2100, the discount rate should be lower – and if even in 2100 the poorer African will still be poorer than the average Britain today, it should actually be negative. Ideally we shouldn't be applying one across-the-board discount rate, but

[5] With $\eta = 1.0$, 1% of GDP in the future has the same value as 1% today. When allowance is made also for $\delta = 0.1\%$, the equivalence (over a 100 years) is about 1.103% of future GDP equates to 1% today.

discount rates which reflect specifically who sacrifices and who gains but that implies adding yet more complexity to already horribly complex models. Picking a slightly lower eta than might normally be appropriate, is one way of offsetting the bias introduced by the simplifications which practicality requires.

So perhaps truth, or at least best judgment, lies somewhere between Stern's base case assumption and Dasgupta's. [Slide 16] But if it does, Stern's overall conclusion still stands – because if you vary the eta to 1.5, increasing the discount rate to about 3%, you still end up with costs of adverse consequences above and possibly far above the low costs of mitigation. The sensitivities in the Stern Review showing costs equivalent to between 2.9 and 10.2% of GDP, even if we take a higher eta of 1.5 (and even before adjustments for equal weighting of human life rich and poor, and before any allowance for uncertain but potentially important socially contingencies.)

Stern's argument for an ethical rather than descriptive basis to the setting of a long-term discount rate is therefore compelling: and his conclusion that the costs of climate change greatly outweigh the costs of mitigation is convincing. The economic case for action is clear.

But one final argument against early action on climate change has been advanced by Björn Lomborg. That emission reductions, whether or not desirable in the long-term, are a lower priority than action on other global problems.

Lomborg organised the Copenhagen Consensus Project, which asked a panel of respected economists to rank possible policy initiatives on the basis of their benefit to mankind.[6] Three proposed climate change projects were ranked bottom of the list, which instead favoured projects to combat AIDS, malaria and malnutrition. Lomborg has paraded the ranking as proof that early action on climate change is uneconomic.

But this interpretation of the Consensus findings is deeply misleading, given the specific question posed:[Slide 17] "Where should the world invest, say, $50bn extra over the next 4 years to do most good?" Because it is quite possible in answer to that question to argue that AIDS and malaria projects should have priority, while also strongly supporting early action to cut carbon emissions.

[6] See *"Global Challenges, Global Solutions"*, edited by Björn Lomborg.

That's obviously true if the world should do all beneficial projects. If climate change mitigation benefits are higher than costs, we should do it, even if the short-term payback to AIDS projects is greater still – we should do both.

But even accepting the discipline of a constrained budget, the idea of a "choice" between AIDS projects and climate change responsibility is largely meaningless because many actions to reduce emissions do not compete for limited resources and indeed some will release resources.

[Slide 18] That's true of many Category 2 actions, energy efficiency improvements. If a company, encouraged by a high tax on carbon intensive electricity but compensated by a lower payroll tax, identifies energy efficiency projects with a positive NPV, it will be no less able to make charitable donations, or corporation tax payments to support the policies the Copenhagen Consensus favoured.

But it's still more obviously the case in respect to Category 1 actions (changes in consumer behaviour). If individuals feel motivated by climate change responsibility or encouraged by a changed taxation regime, to buy a more fuel efficient car or to bike to work, they will have more not less resources available for charitable donations to AIDS funds or to pay taxes to support overseas development expenditure.

Unless that is you believe that the existing pattern of customer expenditures is so perfectly reflective of <u>immutable</u> consumer preferences, that any change to a new pattern (even if induced by persuasion not compulsion) must degrade human welfare, so that the now unhappy bicyclist will take compensating action, spending more than the money saved on other forms of shopping therapy. But in many cases this presumption of an immutable link between existing consumption patterns and welfare, utility, happiness – clearly does not pertain. In an already materially rich society, many of our consumption patterns are not inherently essential to our welfare or happiness, but reflect deliberately stimulated desires and arbitrary habits, both of which can change without any loss of welfare.

Stimulated by a car advertisement probably shot at 4.00 a.m. in northern Sweden, the SUV owner gains psychic benefits from navigating at a snail's pace down the Kings Road, because in his imagination he could have been splashing through a mountain stream. But stimulated by a desire for climate change responsibility, equivalent psychic benefits can be gained from driving a Prius or

G-whiz, while driving a SUV car suddenly create a happiness-degrading sense of guilt. By arbitrary habit, Texans set the air conditioning so low that visitors huddle in sweaters and jackets: set it higher, wear shirts only, and no welfare loss results, and for visitors, a significant welfare gain.

Not all consumer behavior changes can be costless in human welfare terms, nor all category 2 or Category 3 actions, but enough to make the Copenhagen Consensus meaningless when applied to climate change actions.

As one of the economists involved in the Copenhagen Consensus Project (Douglas North) pointed out, the climate change projects should have been marked as "not applicable" in the context of the question posed, rather than as low priority.

Ladies and gentlemen, there are many aspects of climate change economics I have not addressed tonight.

I have not considered the choice between different policy instruments: should we use carbon trading systems, or taxation, or direct regulation. The answer is a mix of all three with different instruments more effective in different sectors markets.

And I have not talked about one very strong argument for early action and for a clear framework for future emission reductions – the fact that the expectation of steadily tightening policy will itself foster technological developments which reduce the costs of mitigation.

But I have considered whether some economists are right in saying that sound economics tells us to delay action and to focus on other priorities. It does not. And I have sought to suggest the role which the discipline of economics should play in deciding climate change policy – as a tool to help us think about preferences and ethics, but not a substitute for judgment and choice.

The more we care about future generations, or more vulnerable people than ourselves, the more we will choose early action. The more we value environmental balance as an end in itself, the more we will be willing to change behavior and to support taxation policies which encourage us to change it. And the more we recognize that some of our consumer behaviors are not immutably necessary to our happiness, but the product of manufactured desires and simple habits, the easier we will find it to change behavior. Economics is a discipline

which helps us think more clearly about choices, not a black box which tells us what our choices should be.