

TUESDAY 25 JANUARY 2005

Present

Elder, L
Kingsdown, L
Lamont of Lerwick, L
Lawson of Blaby, L
Macdonald of Tradeston, L
Marsh, L
Sheldon, L
Sheppard of Didgemere, L
Wakeham, L (Chairman)

Memorandum submitted by Professor David Henderson

Examination of Witness

Witness: **Professor David Henderson**, Westminster Business School, examined.

Q86 Chairman: Professor Henderson, first of all, welcome to the Committee. I think I have spied you in the background on earlier occasions but you are welcome to come to talk to us and we are grateful to you for the written information you have given to us which has been very helpful. As on all these occasions, we hope we will ask the questions sufficiently succinctly and that you will give us not too long an answer to each one so that we will get through as much as possible. Before we ask the questions, is there anything you want to say at the beginning?

Professor Henderson: Only, my Lord Chairman, that I think this is a very important inquiry and I am pleased and honoured to have the opportunity to take part in it. Having said that, I am very happy for you to go straight ahead with your questions.

Q87 Chairman: Thank you very much. If I may, I will start the ball rolling by asking the first question. In your writing, you have focused on two main issues relating to the global

warming debate, the IPCC's projection of greenhouse gas emissions and the IPCC process. Taking perhaps the emissions projections first, I wonder if you could summarise for us your criticisms of both the processes?

Professor Henderson: If I may, my Lord Chairman, I will answer a slightly wider question and come back to the specific point about emissions, for reasons which I think I can make clear. The criticism we have made is not just about the specific projections of emissions that emerge from the Special Report on Emissions Scenarios, it is a broader critique of the Special Report as a whole, part of which extends to other aspects of the IPCC process. If you like, I can enlarge on that a little.

Q88 Chairman: Yes, please do.

Professor Henderson: In its recent Report, the IPCC has determined that the Special Report on Emissions Scenarios, and let me call it the SRES from now on, provides a satisfactory basis for the Fourth Assessment Report which is now in the course of preparation. I think, and those who think like me think, that is not so. The reasons go beyond the question of emissions projections, and indeed if I were writing the critique today I would put less emphasis on that aspect, for reasons I can explain. Why is it that the SRES should not be given the status? First, because five years have gone past since the work was done, five more years will pass before another such exercise as elaborate can be undertaken, and there is a need to check what has happened against actual events. Second, there are a lot of unsolved questions yet, one of which relates to emissions projections. Another such question was raised by Lord Skidelsky in your session two weeks ago and relates to the issue of probability assignments for the scenarios. A third, which features large in my mind, is that major mistakes in approach are still there, in particular, the mistake of making inter-country comparisons of output and GDP on the basis of market exchange rates; that has not been changed and is a serious weakness. The fourth reason is that what I might call the *milieu* of

the Special Report is not representative of economic and statistical thinking generally. That is true of the authors, equally it is true of the reviewers. The range of participants should be increased. Last, and this is a personal bee in my bonnet, the whole Report, which is a very lengthy one, and all the IPCC's work in their very lengthy reports, has no systematic review of what has happened in the past: the historical aspect is missing entirely. I think that a very useful contribution to public enlightenment has not been made, an opportunity has been missed. For all those reasons, which are independent of the specific projections of emissions, I would question whether the SRES should continue to have their status.

Q89 Chairman: Are you able to indicate, briefly, what the effect has been of them proceeding in a way you find unsatisfactory? How serious is it for the end results?

Professor Henderson: If I am right, it means that all the economic aspects of this process are not being dealt with in a way which is sufficiently professional and representative. Just how much effect that would have on the outcome is a different question and a very debatable question, and one which has not yet been cleared up in the technical arguments which have been going on.

Q90 Lord Lawson of Blaby: May I take you up on one of your points, which I think you said was a bee in your bonnet, about market exchange rates. What they seem to be saying is that, alright, it is normally used nowadays in all the international comparisons, it is accepted that in all international comparisons purchasing power parity should be used rather than market exchange rates. What they are saying is "Well, of course, what we're really talking about is inter-temporal comparisons, we're talking about things happening over time, and there it really doesn't make any difference whether you use market exchange rates or purchasing power parity." As I understand it, that is their argument. Before we get into the question of which it should be, what difference does it make, in practice?

Professor Henderson: I think the best way of illustrating that perhaps is from a rather sharp letter that I wrote last year, which I might quote from perhaps: this was in April last year, my Lord Chairman. I wrote to express the concern that “Michael Howard”- that is our Howard, not the Australian one -“is quoted in today’s Times as saying the Chinese GDP is now close to that of Britain.” I wrote to say that Mr Howard should know, or his advisers should know, that is a very questionable and indeed misleading statement: the more accurate statement would be that the Chinese GDP now is probably more than four times that of Britain. So that one’s picture of the world is altered very considerably, if one takes a PPP comparison rather than a comparison in market exchange rates.

Chairman: That is a fairly startling statement, for some of us anyway. Can you elaborate on that?

Q91 Lord Marsh: Can I ask a question on that? As I understand it, the generally accepted Chinese GDP growth rate at the present time is around eight per cent, or so, per annum, which a lot of people believe is an exaggeration.

Professor Henderson: The growth rate, yes, that is true.

Q92 Lord Marsh: Are you saying that is much faster?

Professor Henderson: That is a good question. I am not querying the growth rates, which are certainly high though there is room for argument about exactly what they are. What I am saying is that the level which the Chinese economy has reached now, of course - largely as a result of these very high growth rates - is such that its GDP, on the best estimate I could produce for the Committee, is about four times that of Great Britain and more than twice that of Japan, which is normally reckoned to be the second largest economy in the world, if, which you should not, you judge by market exchange rates.

Q93 Lord Lamont of Lerwick: I wonder if I could pick up one of the points you made when you were criticising this and you said there had been no systematic review of what had happened in the past. Could you just enlarge on that and say precisely what you would like to have seen reviewed?

Professor Henderson: Certainly, Lord Lamont. I should say to the Committee, this is a personal view of mine and not one that I would put forward as representative. I think that any such inquiries that IPCC embarked on, and the Special Report on Emissions Scenarios embarked on within it, ought to have contained a careful examination and presentation of past trends and all the things that are of interest, a very wide range of things that are of interest, an informal commentary on those trends, and comments on the ways in which this analysis could throw light on the future. There is no such thing. None of the participants, as I see them, certainly on the economic side, is historically minded. No economic historian has been asked to take part in this.

Q94 Lord Lamont of Lerwick: There have been analyses of emissions and of temperatures?

Professor Henderson: Yes, but they are all looking forward.

Q95 Lord Lamont of Lerwick: I thought, of the past?

Professor Henderson: If you look at the SRES, you will find very little on this. I would have liked it to be almost a separate exercise. To repeat, this is my personal line.

Q96 Lord Lamont of Lerwick: Certainly in the evidence we had from Sir John Houghton there was a lot about the past?

Professor Henderson: There is not much about the past presented in the sort of way that I would like, with facts, figures, analysis, commentary, and even in the Report of WG1, with

which of course Sir John was very closely associated. Perhaps I am asking too much of that. As I say, it would have been part of public enlightenment and it has not been provided.

Q97 Lord Macdonald of Tradeston: Professor Henderson, I am just looking at this IPCC press release, which counter-attacks and talks about disinformation and criticism mounted by two so-called independent commentators, actually it dignifies it by C and H, and goes on to quote some other academics who became critical of you and of you and Ian Castles. That includes Professors Manne and Richels in California, Professor Richard Tol in Hamburg, Drs Alfen and Holtsmark in Norway. Obviously, they have got quite a heavy group of academics lined up in criticism of yourself and Ian Castles. Have you anything to say in reply to that?

Professor Henderson: Yes; a small point but a significant one. The only authors that are mentioned in the press release are Manne and Richels and that refers to an article which has already been subject to revision. I think it was mentioned, if I may be a little malicious, on the principle that my enemy's enemy is my friend or my critic's critic must be right, so that has not weighed on me very much. The Norwegians whom you mentioned have made a very good point, which we may well come to, but that is not mentioned in the press release. On the press release, I would make three points. First, I have not lost a wink of sleep over those references you quoted. I lost a few winks, or a few winks were put in jeopardy, by three other features of that press release, in ascending order of importance. One, in its first paragraph it exudes complacency. Two, there is a reference later on to this question of PPP versus MER, in which they say that this is no different, it does not change the economy, it is like measuring temperature in Celsius or Fahrenheit. I just put it to the Committee that whether the GDP of China is roughly equal to that of the United Kingdom or four times as great goes beyond questions of Celsius versus Fahrenheit. This is not trivial, it is not non-substantive. Last, this did worry me, as a bureaucrat. I am an ex-official and I did not like to see the following incongruity, that the IPCC has said, formally and in writing and it has been repeated, that it

would not reply to criticisms of the SRES, but this **is** a reply and it was not just a personal inspiration on the part of the Chairman. First, he is the Chairman. Second, it appeared with the IPCC logo. Third, you can find it now on the IPCC website, in a slightly less impolite form than the original, as one of only two press releases which the IPCC issued for the calendar year 2003. I wonder what these officials are paid for, whether they mean what they say - that the IPCC does not wish to reply, as such, which I would respect, or whether they stand by what they put on their website.

Q98 Lord Macdonald of Tradeston: And Professor Richard Tol of Hamburg, whom I believe we might be talking to at some future point, do you have a response to that?

Professor Henderson: There are interesting technical issues which I am rather looking forward to discussing with your Special Adviser, Professor Pearce. The only critics who count, to my mind, sufficiently for it to be worth considering today, are the Norwegians, for reasons which I can explain.

Q99 Lord Lawson of Blaby: Professor Henderson, let me ask you the question about the IPCC's assumption of the convergence of incomes per head in the developing and the developed world over the next 100 years. There are a number of questions in that area. The first is, like the question I asked earlier but I do not think you answered it quite, what difference on the convergence front does it make whether you use market exchange rates or purchasing power parity? The second thing is, is this convergence there because there is some historical evidence to suggest this is likely to happen, or is it just an assumption made because it would be nice if it did happen? The third question is - and you know the IPCC system process backwards, I do not - is this convergence a kind of average of the poor countries of the developing world, or does it happen to each country, does each country converge, all together? If it is an average, are they saying that those who run their economies

most successfully, most intelligently and with a minimum amount of corruption will do far, far better than the developed world, to offset the fact that those who run their economies in a shambolic way with masses of corruption - and I do not want to name countries but we know plenty that do this - presumably are not going to converge, so the others are going to have to overtake everybody else? How do they work this?

Professor Henderson: If I could answer Lord Lawson's last question first, because it is the simplest, my Lord Chairman. The projections are made on the basis of regions and there are two regions of developing countries. Nothing is said of individual countries, nothing is said about the questions you raised about possible misgovernment or good governance. These are aggregate projections for whole areas of developing countries; one is for Asia, the other is for Latin America and Africa and the Middle East. To my mind, that is not objectionable, that is not a worry on my part. I think it is quite reasonable to look at groups of countries and make aggregate projections. It is also not only reasonable, but I think what most of us would want, that convergence is built into these projections. Lord Layard made the point, two weeks ago, I think, that in fact we would expect convergence from good arguments in theory and from experience.

Q100 Lord Lawson of Blaby: What do you mean by convergence?

Professor Henderson: Convergence of real income per head, GDP per head, as between the poor regions and the richer.

Q101 Lord Lawson of Blaby: I am sorry but I think we need to be clear about this. Is convergence just that the gap reduces or that the gap is eliminated? That is what I am trying to get at.

Professor Henderson: The gap is progressively reduced until it becomes quite small.

Lord Lawson of Blaby: Over the next 100 years.

Q102 Lord Sheldon: This is all a politically correct way of putting it, is it not, over 100 years, which nobody can ever guess at, and that you have got a politically correct solution, that everybody is going to be happy altogether in 100 years' time? The optimism underlying this is really quite astonishing.

Professor Henderson: There is an element of that, Lord Sheldon, but let me say first that you would expect, it is reasonable to expect, in the light of both theory and experience, that for poorer countries, generally speaking, at least that the potential, given the conditions that Lord Lawson emphasised, is there. To that extent, I do not think it would be fair to say it was political correctness. However, if you look at the reasons which the scenario-builders have built in for this overtaking of the rich by poor countries, there was an element which you could describe in that way. In some of the scenarios they assumed that there was an element of equity, and by equity they meant policies which would be aimed at closing the gap and would succeed in closing the gap. We say, and I think it was a fair criticism, that it is a strange way to project the future on the basis of events which would make the world a better place if they happened, rather than looking at what might or is likely to happen. It remains the case that the idea of poorer countries catching up the richer is a perfectly reasonable one to entertain.

Q103 Lord Lawson of Blaby: Would you like to answer the other bits of my question?

Professor Henderson: Yes. With apologies for turning you upside down, Lord Lawson, in my book it makes no difference what assumptions you make about exchange rates in projecting growth rates because such assumptions are not relevant. This is one of my basic disagreements with the model-builders. It makes a difference to them, for the following reason, that if you take market exchange rates as the basis for comparison, in the year 1990, from which they start and from which the process of built-in convergence operates, poor countries are shown as very much poorer than they really are. The gap is greatly overstated.

China is one of them but it applies to all developing countries. They have built in an overstated gap and the convergence they build in involves the closing of that overstated gap, so they have given themselves reasons for a much faster rate of convergence than they would have had if they had not started from market exchange rate comparisons. Does that answer your question?

Q104 Lord Lawson of Blaby: Yes, I think it does. The question I was about to ask, relating to your previous answer, and I apologise for interrupting you when I should not have done, was that you said in an earlier context a moment ago you regretted that there was not enough economic history, that it was all looking at the future, and so on. On the vision of economic history, how does the rate of growth of the poorer countries, the developing countries or these two regions that you were talking about, over the next 100 years compare with what we know historically of the rate of growth over the past 100 years?

Professor Henderson: I have looked closely at only the next 30 years, which, for me, we should be giving a bigger weight than what happens afterwards, though your question is perfectly reasonable. Over the next 30 years, if I am right, and I have a table which I can give to the Clerk, the projections are higher than those of others.

Q105 Lord Lawson of Blaby: That was not the question I asked you. How does the rate of growth which they are projecting compare with the rate of growth in the past?

Professor Henderson: It depends on the period you take. It is faster over the next 30 years, but I would not criticise the scenario-builders necessarily for taking the rates of growth which they have. I would criticise the way in which they have arrived at the results, in terms of a faster rate of growth over the next 30 years, if I am right, than almost any other people looking forward have decided on.

Q106 Chairman: When you say, other people looking forward have decided upon, what do you mean by that?

Professor Henderson: In the table, I have put together and my co-author has put together a set of projections of growth for developing regions over the next 30 years, from scenario-builders and others, and, in that, all but one of the SRES scenarios come out as much the highest. That is not to say they are wrong, but only that they are a bit out of line. One reason why they have gone that way, I think, is because of their very questionable starting-point.

Q107 Lord Elder: In the processes of Integrated Assessment Models there is the transmission from emissions through to warming through to economic damage, as we understand it. I would be grateful for your views on the view expressed to us by Dr Hope, that even if emission scenarios are pretty significantly in error it makes little difference to the proposed rate of warming?

Professor Henderson: I will make two comments. First, I was a little surprised when, I think it was, Dr Hope said that it would make little difference, because the second working party, WG2, of the IPCC has a diagram prominently, right at the beginning of its report, in which it shows how the emissions feed into quite large differences in impacts. I have given a copy of the diagram to the Clerk. I was a little surprised. I thought that Working Group, in fact, put a lot of weight on the emissions. Our criticism of the SRES, in this connection, was that it exaggerated the likely emissions projections because of the high levels of growth that it had attributed to developing countries. Now I think that has been overdone, for reasons which I can explain and which do not make me feel any more kindly towards the projections.

Q108 Lord Elder: Would you like to explain, please?

Professor Henderson: Forgive me, Chairman, if I become a little more technical than I would like. It is hard to avoid, and please stop me if you think I am taking too long over this. If we

start with the assumption, which I believe to be correct, that the GDP per head of poor countries was greatly understated by the use of market exchange rates, then an interesting conclusion follows. Let me illustrate it by looking at China. If you take Chinese GDP as a proportion of world GDP at PPP rates, it is about one-eighth. If you take it at market exchange rates, it is about four per cent; a big difference. Chinese electricity consumption and supply on the latest figures, was about 12 per cent of the world total; those are International Energy Agency figures. If you look at those figures, what conclusions do we draw? I would draw the conclusion that those figures are consistent with the view that China's GDP is 12 per cent and not four per cent of the world total. The scenario-builders draw the conclusion that Chinese energy use is very inefficient. The ratio of energy to GDP appears higher because they take a much lower figure for GDP. There is more than one international agency, I am sorry to say, which has published analyses which purport to show that what you might call the energy-efficiency of developing countries is much lower than that of rich countries because they have taken these low estimates, invalid estimates, of poor countries' GDP as a starting-point.

Q109 Lord Lawson of Blaby: Let me try to understand this a little better. Are you saying that they measure the GDP at market exchange rates and the energy consumption at PPP?

Professor Henderson: No. Energy consumption is what it is. It is in kilowatt hours, and other physical units.

Q110 Lord Lawson of Blaby: That is the equivalent of PPP because you are putting it in real terms?

Professor Henderson: PPP does not enter into the energy measure. You are relating the physical energy measure to GDP.

Q111 Lord Lawson of Blaby: You have to express the energy consumption in money terms, do you not?

Professor Henderson: No. It is physical, just as emissions are physical, just as CO₂ concentrations are physical. The energy is measured, normally, in million tonnes of oil equivalent.

Q112 Lord Lawson of Blaby: How do you measure million tonnes of oil equivalent as a proportion of GDP unless you express the million tonnes of oil equivalent in money terms?

Professor Henderson: It is not a proportion, it is a ratio; they do not have to be the same units.

Q113 Lord Sheldon: Is the personal consumption of electricity as a proportion of industrial consumption of electricity much the same in China as it is in Western countries?

Professor Henderson: It is not the case, in my opinion, that poor countries use energy inefficiently in relation to GDP.

Q114 Lord Sheldon: Or in different ways?

Professor Henderson: In different ways, certainly, if you look closely. But if you underestimate GDP, you overestimate the extent to which the countries for which you are underestimating the GDP are using energy in a more lavish way.

Q115 Chairman: We still come back to the central point that if the GDP of these underdeveloped countries is significantly higher than we are led to believe, a sovereign of convergence is not as dramatic as it might appear?

Professor Henderson: Indeed. Can I just finish my regrettably technical answer?

Q116 Lord Lamont of Lerwick: Averages would be GDP per head?

Professor Henderson: I still have not answered Lord Elder fully, I think. Let me put it this way. If we are right, and I think we are right, the initial gap in GDP per head between poor and richer countries in 1990 has been greatly overestimated. By the same token, what I might call the energy-efficiency has been greatly underestimated. In the process of projecting large increases in GDP per head for poor countries, the model-builders build in a very rapid process by which energy in relation to GDP declines. They are closing what I might call an imaginary energy-efficiency gap. That is the nub of the Norwegian criticism. But what we have written, and I think they are right.

Q117 Lord Kingsdown: Can we turn to the IPCC process. Sir John Houghton told us, I think, that the peer review process there is very extensive and involves seemingly hundreds of scientists and economists and all sorts of people. How confident are you that this results in the best of the science and the best of the economics being heard?

Professor Henderson: As for science, I would hesitate to respond, Lord Kingsdown. As to economics, two points. First, the economists, people concerned with the economic work, are not very representative of the profession, partly because the main actors in the scene, and quite rightly given the approach that was decided on, are scenario-builders. Scenario-builders are not very representative in the profession because people who are bold enough to look 100 years ahead, and good for them that they do, are not very representative of a profession where most of us are uneasily conscious that we cannot predict what is going to happen in six months and in any case are looking at other things. The range of economists directly involved and economic statisticians directly involved is less wide than I would like to have seen. In relation to the economic aspect, I would say, to comment on what Sir John Houghton said, that there is good reason to question both the authority and the representative status, and the claim to that status that the IPCC makes on its own behalf. I do not question the numbers of people involved, they are correct. I do not question that the procedures are meticulously

followed, I expect they are. I certainly do not question that peer review takes place, it does. As a result of looking at this - to my surprise, while two and a half years ago I had no idea I was going to be involved in these issues - I have come to feel that building in peer review is no safeguard against dubious assumptions and procedures and conclusions if the peers are drawn from much the same *milieu*, as I think has been the case.

Q118 Lord Kingsdown: It sounds almost as though the longer the scenario and more unreliable the outcome the more, dare I say, adventurous are the economists who are involved in it?

Professor Henderson: True, but I would not reproach them for adventure. That was what they were asked to do and I do not reproach them. Personally, I hope, if I may express the hope, my Lord Chairman, that if the Committee has time they will call the lead author of the scenario report, Professor Nakicenovic, and give him the chance in person of saying what he thinks of these criticisms. I would not reproach them for that. I do think that the whole process on this side has been designed in a way which does not let in people, I am not saying necessarily deliberately, who may have contributed something different. One such voice is that of the national account statisticians, and one of our strongest supporters, in fact, in the interesting controversies we have been engaged in, in learned journals, with the scenario-builders and others, is in fact an eminent, now retired, statistician from Statistics Canada. Perhaps I could quote what he said in the course of this and this was in an article which I think I have already given to the Clerk. He said: "I cannot help being shocked by the contrast between the scenario team's bold assertions and peremptory dismissal of the arguments advanced by Castles and Henderson and their manifest ignorance of the conceptual and practical issues involved in developing and using inter-country measures of economic product." That is one specialist complaining about others, but I do think, and Castles himself

had argued for this before, that it would have been a good idea to involve people from National Statistical Offices in the kind of process which has been going on.

Q119 Lord Sheppard of Didgemere: Professor Henderson, we have heard today and also read, of course, some of the public responses of the IPCC to some of your criticisms of both processes and the actual scenarios. Do you want to lift the curtain just slightly and tell us what has happened behind the scenes? Do you get the feeling that they have actually taken your criticisms seriously, have they debated them properly with you?

Professor Henderson: I think there are two different answers to that. First, as far as the scenario-builders are concerned, they took our criticism seriously, they wrote a long article explaining why they thought we were wrong, and they wrote another long article in response to the article with which we had followed up our first one. There is no question that they have taken this seriously and they have presented their case quite fully. They have not in the least tried to brush us off; on the contrary, they were upset, and very understandably so. My professional career now extends to nearly 60 years, but it is the only time I have had to write an article at the end of which I put in a little appendix on questions of protocol and conduct. I do not blame them for that. Now if we turn from the scenario-builders to the IPCC in general, it is perhaps another story. I thought that press release was a very surprising document, for reasons I have mentioned, and the IPCC clearly has taken the line that what we are saying, insofar as it is not wrong, is unimportant. I am not saying necessarily that was wrong, but I do think the whole process which I have described is one which is less representative and less thorough than they claim.

Q120 Lord Sheppard of Didgemere: I do not know how you measure the audience, or the family audience, but are you winning or losing the debate?

Professor Henderson: You would have to ask a more neutral observer.

Q121 Lord Sheppard of Didgemere: How does it feel to you; you are not about to give up, are you?

Professor Henderson: For me, if I were stating the case now, I would make two changes in my arguments. They do not weaken the arguments, in my opinion, I would just state it in a different way. First, I would withdraw the criticism, or, at least, not emphasise it so much, that the scenario-builders' procedure exaggerated emissions projections. The reasons are rather complex reasons, which I will try to sketch out. In fact, they have a built-in, legitimate, non-exaggerating factor and I had not taken account of that, the Norwegians pointed it out, so I would not protest. For reasons I have stated at the beginning, that does not weaken the other reasons I have for thinking that the SRES should not be taken, as it is being taken, as the basis for the Fourth Assessment Report. The other point I would make is, and this is something, as counsel for the defence for the scenario-builders, I would certainly argue, when we wrote we said, "Look, you're ignoring clearly-stated doctrine on the use of PPP. Nothing could be clearer than what is said in the system of national accounts in 1993, which is not referred to in your report, that purchasing power parities must be used and market exchange rates must not be used for inter-country comparisons do output." In saying that, we thought we were representing a clear majority of others in the profession of economics and statistics and economics. Not for the first time in my life I discovered that our profession – or trade, as Lord Lawson would prefer to call it - is more disordered than I thought. Indeed, the scales began to drop from my eyes in April last year, my Lord Chairman, when seated in the House of Lords, listening to questions being put by Lord Taverne and by Lord Lawson himself about the handling of economic issues by the IPCC, I heard one of your noble colleagues actually say that the choice between MER and PPPs was a matter of taste. I must say, that rather shocked me. We have found other instances since. Economists are less agreed than I

thought, but that has only made me feel that more people than I thought have to be brought round to what has been called the creeping acceptance of purchasing power parity.

Q122 Lord Sheldon: If you had the responsibility, and we have dealt with some of these matters already, how would you have gone ahead in looking at the IPCC process, how would you have started it?

Professor Henderson: That depends what responsibilities you are putting on my shoulders, Lord Sheldon.

Q123 Lord Sheldon: The lot.

Professor Henderson: If I can answer that in a way which perhaps you did not quite intend. If my responsibilities were those of a Treasury official - and I have been a Treasury official, and when I was in the OECD my clients were Treasury officials - I would have looked at this whole process with a much more critical and much more worried eye. This echoes a point you yourself were making earlier in the Committee's hearing, because I have the feeling that quite large, and possibly very large, expenditures are being undertaken on the basis of what is thought and believed about what might happen in the very long run, beliefs which, in fact, are not strong enough to bear this foundation. If I were a Treasury official I would be worried about that and I think there should have been more worry.

Q124 Lord Sheldon: Would you have settled for 30 years rather than 100 years, is the answer?

Professor Henderson: I would have said, "Let's look very hard at 30 years and let's not do so on the basis just of the people you have involved now," I am told there are now 800 members of the Government Economic Service. Allow me to boast. Two score and four years ago I wrote an obscure article advocating the creation of a Government Economic Service, though I

do not know that it had much to do with the result. I feel very strongly about the use of economics in administration. I cannot think why it is that, with so many of these people who seem to be involved in this process, the Treasury have not asked themselves the questions we have asked and made the points we have made, and I hope the Committee will ask the Treasury that, because certainly they have not responded to what I have been saying.

Q125 Chairman: Do national governments have much say in who is appointed to these bodies?

Professor Henderson: Yes, almost the entire say.

Q126 Chairman: They have the complete say and they do not want to involve themselves?

Professor Henderson: They have delegated to IPCC, but the whole process, quite rightly in my opinion, is closely supervised by governments. The IPCC is technically the creation of two UN agencies, so it reports to them, but the UN agencies themselves are government-controlled and they report to their member governments. The member governments are very strongly represented, as they are bound to be - again I think this is quite right - at the IPCC plenary meetings and particularly in the last stages of preparing the big reports, the Summaries for Policymakers. My criticism is of government departments just as much as of the IPCC.

Q127 Lord Lawson of Blaby: Specifically, what would you like to see the Treasury doing now that it is not doing?

Professor Henderson: I would like to see the Treasury making it difficult for the IPCC to continue with business as usual, which clearly they are determined to do. I have a very specific way into that, which I have suggested, in fact, more than once in different places. After talking to all the others concerned in other countries, the Treasury should instruct its

delegates to the next meeting of the OECD Economic Policy Committee to request the Committee to look at these issues, to open the issues that we have opened up.

Q128 Lord Sheppard of Didgemere: I want to ask a bottom-line question, of which I realise there are many, many variables. Supposing we, or more relevantly the IPCC, accepted all of your arguments and rolled over, what would be the temperature range that you would be projecting, all other factors remaining the same? Is it quite a dramatic impact or small?

Professor Henderson: I am worried about the way a process is being handled rather than the final results, which are very difficult for a lay person to judge. I do think that there is in this whole process what I might call a tendency towards alarmism, but I may be wrong.

Q129 Chairman: Thank you very much. I am really very grateful to you and the whole Committee is very grateful to you for coming to give us your views on these things and answering the questions in a clear and precise way. It has been very helpful to us in our inquiry.

Professor Henderson: Can I say just one thing, my Lord Chairman. If at any stage you or any member of the Committee, or your Special Adviser or the Clerk have any questions or points on which they would like my opinion or to have any information from me, I am at your disposal.

Chairman: Thank you very much indeed. We are most grateful to you.

Memorandum submitted by Professor Richard Lindzen

Examination of Witness

Witness: **Professor Richard Lindzen**, Massachusetts Institute of Technology, examined.

Q130 Chairman: Good afternoon, Professor. I gather you have had quite a journey getting here and we are extremely grateful to see you in good shape, if I may put it that way. Thank you very much for coming and answering questions. We have got a number of questions that we want to ask you, but is there anything you want to say to start the ball rolling?

Professor Lindzen: I think the public is being misled as to the nature of the controversy and the science. I have given you a deposition and I will not repeat it at length, but when your Prime Minister assured you that the bulk of scientific opinion was on one side, in many ways I do not disagree with that. I want to clarify that the disagreement is not over whether temperature has been changing; almost everyone agrees somewhere around the order of a half degree change over the last century. No-one disagrees that carbon dioxide is a greenhouse gas and that doubling it would increase the greenhouse effect by about two per cent. No-one I know disagrees - there may be a few - that man has played a role in the observed increase in CO₂ between about 290 and 380 parts per million. Where the disagreement exists is not over that but over whether that is an alarming statement. The reason that is argued is, in some ways, the following. The people hear about a doubling of carbon dioxide, let us say we start at 280 and go to 560, we are now at 370, 380, and they think of a distant future, maybe not so distant, probably the end of this century. When they hear that this may account for four or five degrees or, depending on your scenario, five-something, they do not question it, and I think there is a very strong reason to question it. That is to say, what is important for climate is not the level of carbon dioxide but how much you have increased the greenhouse effect; they are not the same. When you look at how much we have increased the greenhouse effect

since the late 19th century, it is about three-quarters of what one would get from doubling carbon dioxide. I explained this in my deposition so will not bother you with it. The point with that is, if you expect four or five degrees from a doubling of CO₂, you expect almost as much, three-quarters as much, from three-quarters of that forcing, and we have seen only a half degree. We know that if you just kept everything constant, doubling carbon dioxide would give you one degree of that, which means that today we should have seen three-quarters of a degree, which is already more than we have seen, but the models are saying we should have seen three, which is about six times more than we have seen. You have a choice in that, namely to say that the models are wrong, they are overpredicting what is happening, or saying the models are right but an unknown process has cancelled the difference. That is where the argument lies. Are we to say that the response today indicates low sensitivity, or we go with an unknown process, cancelling the difference? I think that should be understood very much. A half degree is small on several counts and one of them has to do with a feature that I think laymen somehow have difficulty with, namely, climate varies without any forcing. Things like *El Niño*, and so on, do not have an *El Niño* forcer, it is just the system wobbles all of the time, and this is true even in models, incidentally, you run them with no forcing and they wobble. You look at a temperature records and it oscillates and goes through all sorts of things. We do not know what causes it and most of the time we know the system will do it without any cause whatsoever. It means, when you are comparing observations and what is called the null hypothesis, the null hypothesis is would you have the agreement between observations and a picture that just had the random internal variability? That would consist in a horizontal temperature that was broadened to represent the extent of the internal variability, it might be about 0.4 or 0.5 degrees. If then you took these famous curves of temperature, which even though they look dramatic are still half a degree, and broaden them to indicate the uncertainty in the observations, which is about plus or minus 0.15, 0.2 degrees, there is no

time when these two curves do not overlap, which means, on the face of it, you do not have any reason to expect the need for any forcing whatsoever. In engineering terms, there is a saying we have a very poor signal to noise. I would leave it with that as a summary of my views on the subject.

Chairman: I think you have pretty well answered the question I was going to ask you, so I will ask Lord Marsh if he would like to start.

Q131 Lord Marsh: One of the problems, as you know, for some of us on this Committee, is that we are not specialists in this field at all, and listening to people like yourself it is fascinating and produces increasing bewilderment at the level of magnificence, so we are trying to catch up on this. To try to get a simple question - we are on only the third meeting of this inquiry - what sort of temperature increases, plus or minus, by, say, 2100, do you think are at issue here?

Professor Lindzen: It depends on a lot of things. I see no reason at present, with or without Kyoto, why carbon dioxide will not increase. As I say in the deposition, radiative forcing, which is the climate forcing, does not increase proportionately, it increases ever more slowly. I do not expect to see a huge increase in the forcing. Right now, it is close to three watts per metre squared, do not worry about what that means. I do not see it going to much more than four, maybe five. Even if one quadrupled CO₂, one is not talking of more than about seven or eight in that range. The evidence so far, contrary to the models, suggests to me that the sensitivity to four watts is of the order of a half degree, so even with the quadrupling of CO₂ I would not see more than a degree. It is true that the models are predicting four degrees, but the same models predict three degrees for today, and we do not see that. In addition to that you have other pieces of evidence, I could explain if you wanted but they are technical, they are things that determine sensitivity, that have to do with the time of response to perturbation, so technical issues. They point to low sensitivity. The one thing that points to high

sensitivity is models, and these models for economists I find I have to explain. There are in the world of models, I think, a variety of different kinds. There are models that are “constructs” for fields where you do not have fundamental equations, where you put in how you think the system behaves and you use the model to see the complicated ramifications. There are other models, like most of the climate models, which are based nominally on physical laws, where you do not have too much choice in the equations, you have plenty but, the question is, can you solve them? The difficulty with meteorology and climate models is we know the system depends on scales ranging from metres to the radius of the earth. We do not even anticipate a model that can encompass these spatial scales or the timescales, we are talking about thousands of years. As a result, the models we build do not correspond necessarily to the underlying equations and they can produce results that differ from the solutions, and this is particularly important for certain things when you are transporting things, water vapour or clouds. Clouds are the classic case. The IPCC freely acknowledges that there is no model today that gets cloud cover within 40 per cent of what is observed, and 40 per cent in terms of radiation represents something an order of magnitude bigger than the effect of CO₂.

Q132 Lord Lamont of Lerwick: It is probably a little unfair but I wonder if I could read you just one sentence of the evidence we had last time from Sir John Houghton and ask you to comment on it. “If you come to the 20th century, you find that the increase in global average temperatures is phenomenal” that is the word he used “compared with any variation over the whole millennium.” Could I ask you just to comment on the validity of comparisons over a millennium and, secondly, the use of the word ‘phenomenal’?

Professor Lindzen: Could I reverse that to deal with phenomenal? You can give it any word you want, phenomenal, unprecedented, record-breaking; it does not change the fact that it is a half degree, we are talking about a half degree. Do not let words befuddle you. A half degree

is to be compared with the model expectation of three. Seventeen years ago – it pains me to think it is going on this long - when the issue started, alarmists wanted to avoid the temperature argument, because they were aware of that. Then they realised that the public did not look at numbers, it was like looking at the stock reports for the day, if the market goes up one point it looks like it goes up a thousand points, nobody can tell the difference. Phenomenal, I think, does not make any sense. It is small. Unprecedented is the other thing, in the millennium. I do not even want to get into that argument. It reminds me very much of, I do not know if you want an anecdote but once I had a friend who went into the Army and he came back home after basic training and was saying he had learned something very strange. In basic training, they were explaining to the recruits what to do if an enemy came at you with a bayonet, and they gave them a technique so that they could always disarm the enemy and kill them. He said he had reached the conclusion that if his enemy has a bayonet and he has a bayonet the first thing he should do is throw away his, because he had a technique for defeating someone with a bayonet. We have thousands of thermometers and we have trouble measuring the temperature to better than a couple of tenths of a degree, averaged over the globe. The record going back a thousand years is based on a couple of handfuls of tree rings which only observe growth in the summer. If that is good enough to tell you within tenths of a degree, we should throw away our thermometers. The truth of the matter is, when the people who wrote that drew their uncertainty, you no longer could speak of ‘unprecedented’. The statement that it is unprecedented, by any argument at all, and plenty of people say you cannot measure it back with any meaningful accuracy, still it is not unprecedented, the statement has to be political.

Q133 Lord Lamont of Lerwick: What about isotopes then?

Professor Lindzen: In general, isotopes are used delta 0-18 for much longer periods. They have very coarse time resolution by this standard. They would not be too helpful on it. They

have tree rings, they have bore-holes, things like that, there are various techniques you can use, but they are all inferior to thermometers and yet they are talking about tenths of a degree.

Q134 Lord Macdonald of Tradeston: Just pitching forward now rather than back. Sir John, talking to us, also asserted that even a one degree centigrade change in average surface temperature in a hundred years would cause all kinds of unacceptable climatic problems. Do you agree?

Professor Lindzen: I do not. I think he differs even with the IPCC on this. This is a problem of procedure. The IPCC has a lot of people speaking for it. That tends to override what the text actually says. These days, people are saying, “Yes, two degrees.” It is always arbitrary. The thing I think you have to remember is, here in London, or especially back in Boston for me, or in Paris, or any other place you wish to name, the temperature variability is far greater than it is for the global mean. Each of us is living through fluctuations of several degrees from year to year in the place we live. Moreover, each of us lives through a season, lives through day/night, we are talking about 20 degrees. I find it very hard to believe that, since our agricultural systems, our lifestyle, all encompass such large changes, some global mean is going to swamp it.

Q135 Lord Lawson of Blaby: You have been very eloquent and it is fascinating, but are you a lone voice or is there substantial support for your views among the scientific community?

Professor Lindzen: I think there is no core of the scientific community.

Q136 Lord Lawson of Blaby: You must speak to your fellow scientists from time to time?

Professor Lindzen: Yes, of course, all the time, because some of the work is really just quite independent of one’s position on this. I think, at MIT, Chicago and other places I deal with, even at the Laboratory for Dynamic Meteorology in Paris, where I spend a lot of time, most

people realise the issue is a bit dodgy, but there is a problem, and you say it and it is kind of like being a skunk at the party. In Europe, the Laboratory for Dynamic Meteorology's climate modelling effort exists because of global warming. At the Max-Planck Gesellschaft, their climate modelling effort exists because of global warming. The Hadley Centre exists because of global warming. The only place in the world where there were efforts before global warming was the US, but even in the US the first President Bush responded to the alarmism with two billion dollars a year for research. I do not think you are going to see much objection to the alarmism, but the points of agreement, when they say that scientists all agree, it is basically what I have written in this deposition. Scientists have learned of what I call the iron triangle of alarmism, that they can utter innocent statements, such as the one the Prime Minister said, that are completely consistent with nothing much happening, so they have not compromised their scientific integrity and yet these will be interpreted with alarm, and the body politic, at least in my country, will respond by feeding money to the science. Why would anyone get in the way of that?

Q137 Lord Lawson of Blaby: That I understand very well, but the suggestion is that policy decisions, which might be economically extremely costly, should be based on what you call alarm. So it is not just academic corruption, in the nicest possible way, academics being human like everybody else, put it that way, there is more involved?

Professor Lindzen: Of course there is. I think, and here I am not speaking as a scientist, we have reached a stage in our country where the belief is, if the politicians want to go along with this and are gullible enough, it is their problem. I think there is that degree of social disintegration.

Q138 Lord Lawson of Blaby: Lord Lamont mentioned an important bit from the evidence that this Committee received last week from Sir John Houghton. Have you seen a transcript of his evidence?

Professor Lindzen: No, I have not, but I have heard of it.

Q139 Lord Lawson of Blaby: If you have heard about it, is there any comment you would like to make on any of the things you have heard?

Professor Lindzen: Yes; sure. First of all, I heard him say that my comments are simply verbal and I have presented nothing on it, so I have brought with me my list of peer reviewed publications. In the last four years alone there are 28 on the issue of feedbacks, and so on. The other thing is, he argued, and this relates to the IPCC, that the IPCC Third Assessment rejected the views, and this really presents a problem. I do not know how familiar you are with the procedure, but each chapter has a set of lead authors, of the order of ten or a dozen. They have a co-ordinating lead author. Each of the lead authors is responsible for a page or two or three, together with two other authors. In some ways, in science, this is one of the most expensive volumes I know. I estimate, per page, in travel expenses alone, plus missed work, it amounts to about \$40,000 a page.

Q140 Lord Kingsdown: Not to mention global warming?

Professor Lindzen: Right. If you go to the chapter on physical process and climate feedbacks, you do not find disagreement, that we do not know how to do water vapour, we are uncertain about the positive feedback. When you get to clouds, you get open admission that they are completely uncertain and a fundamental weakness in the predictions, and it is understood, but we were not permitted to say it, that these are fundamental to the predictions of large warming. That was a little bit peculiar. You do not find the disagreement that John is talking about. The only place you begin to see anything is in the Summary for

Policymakers. This has been a characteristic of these documents from the beginning, as far as the press goes, as far as politicians go, they see the first two lines and maybe the first paragraph and that is it. Typically, in the Second Assessment, the line which carried the day was a discernible human impact on climate. That was the smoking gun for Kyoto. Discernible suggests it was less than the total, and that the total is about one-sixth of what the models predict does not seem very alarming to me, but it was enough to get people riled up.

Q141 Lord Lawson of Blaby: Lastly, can I refer to one particular part of his evidence, which is exactly the answer which Lord Lamont quoted, the very first part of his answer. He went on to say: “It” - that is the average global temperature - “has been a steadily rising trend during the 20th century.” Then he says that for the first half of the century it was nothing to do with greenhouse gases because there were not greenhouse gases, it must have been something non-anthropogenic. Then he contradicts himself somewhat by saying that there was no temperature rise between 1950 and 1970, and then he says, and I quote: “From 1970 to the present time there has been a very steady increase in water vapour. The rate of increase is larger than it has been for a very long time, probably for 10,000 years. The total increase during the 20th century is quite out of scale with any variations known to us.”

Professor Lindzen: He said that about water vapour?

Q142 Lord Lawson of Blaby: Yes. This is an uncorrected transcript but I assume it is likely to be right. That, it seems to me, is the basis of his alarmist projections. What is your response to that?

Professor Lindzen: Astonishment. The temperature change over the past century, as you pointed out, is irregular. It went up rather sharply from 1920 to 1940. There is even, between 1919 and 1921, a period where you had a half degree in one year, or two years. Between 1950 and the 1970s you had cooling, and Crispin Tickell even wrote a book about how

society must respond to the coming ice age. Then you had warming and, as far as I can tell, on the surface record, you have rapid warming between '76 and about '85, and then you have fluctuations about it. I remember, when the first satellite data came out and there was only 20 years of it, they said, "Well, you can't make a trend from 20 years' data." All of a sudden people see a peak and they say "That's a trend." There is no steady increase through the 20th century, there is a net increase, and it is a few tenths.

Q143 Lord Kingsdown: You have already mentioned water vapour once or twice this afternoon, but I understand your position is you regard this as having probably a negative feedback effect, that is, that it calms warming down, whereas the scientific consensus, as we understand it, is that it has a positive feedback, that is, that it makes things worse?

Professor Lindzen: The IPCC chapter is agnostic. The models say it gets worse. The modellers acknowledge they do not have the physics appropriate to water vapour. That is the situation as it is now. In 1990 I wrote a paper in which I said global warming scenarios depend on this water vapour feedback; without it you do not get much and we do not know much about it, and they said "Can you imagine any way that would be negative?" I said, "Sure." It turns out, if you have a warmer world and clouds go higher, they detrain, let us say, they merge with the environment where it is colder and you have lower humidity and that could end up reducing water vapour. That has actually been confirmed by studies since then. In the meantime, we wrote a paper in '93 examining this and found that the physics of water vapour in the tropics was different from that. That would work near the top, but, in fact, the source of water vapour in the tropics was rainfall evaporating into the environment, in large measure. We pointed out that the amount raining into environment depended upon how much did or did not rain in these tall, cumulus towers. It is well-known that, when the temperature increases, more rains in the towers and less is available to the environment, so there still could be a negative feedback. Subsequently, we realised that change in the humidity of a region in

a sort of continuous way is rather difficult, even by this mechanism, but what you saw was a short boundary between dry and moist regions, cloudy and clear regions, and the change in area could really be a more significant feedback. We have been working on that since and it looks very much like a negative feedback that would be large enough to swamp any of the positive feedbacks in the model. It is a research area, but it is politically incorrect these days to speak of the world, or the earth, as in some sense being engineered. If any of you have a background in engineering, I do not know, you never build anything with positive feedbacks unless you want to amplify something. You build everything so that the feedbacks hold it in place. The whole notion, I grant you, this is metaphysical, that the earth is a system on the border of instability that is kept from running away only by the gentle ministrations of bureaucrats; it seems to me, strange.

Q144 Lord Kingsdown: Can I just go on to ask you how far your view of the role of water vapour is shared by other scientists?

Professor Lindzen: That is shared universally. All of them agree, no model gets a lot of response to CO₂, much more than you would expect on basic physics, unless water vapour and cloud kick in to make the system much more sensitive than it would be in the basic physics. That is true and accepted.

Q145 Lord Sheppard of Didgemere: Can we move on to the Kyoto Protocol. Your evidence implies that you consider it would have little or no effect on the rates of future warming. Is this because reductions targets are too low, is it that we are doing too much or not doing enough, or what?

Professor Lindzen: In a sense, that is right. What you have with carbon dioxide is, first of all, as I said, you are already three-quarters to a doubling and quadrupling, just do it again. No matter what you do at present, unless you change the amount of these things in the

atmosphere it is not going to change the forcing of climate. Kyoto, for instance, is changing the emissions but it is not eliminating the emissions, so you are still adding to the atmosphere and you can calculate the impact. It is less than a tenth of a degree by 2100, or something like that; it would be unmeasurable. The question is then, as you say, maybe it is not enough. What would be enough to impact the level of CO₂ to get us down from the horrible point we are at now? I should mention, I find this a little bit mind-blowing. If Sir John says one degree will cause all sorts of havoc, we have already had 0.6 and we have seen a world of increased prosperity, we have seen a world of greater food production, we have seen all these things. I do not see the evidence of a horror story there. In any event, getting back to what you are asking, to cut down the CO₂ itself would require not a few per cent below 1990 but probably in the order of 60 per cent below 1990. As far as I know, no-one knows how to do that. Even the IPCC, I should mention, in their Section 3, pretty much concludes we are not going to, even if you believe the models, even if you believe everything about it, they are not going to stop it. The primary concern is can we adapt, and the obvious answer has been that you need the resources to adapt.

Q146 Lord Sheldon: How do you see the work of the IPCC? Do they take full and proper account of all views, however different they may be, or are they all equally represented?

Professor Lindzen: I think it is a very distorting process. As I have said, it has many stages, so you have the writing of the scientific text, or the substantive text; that is done by the lead authors with the co-ordinating lead author, and what I used to refer to as political correctness monitors, people who go around to the co-ordinating lead author, who is chosen by the executive, whereas lead authors are chosen by the Technical Unit at the Hadley Centre, Working Group One. The co-ordinating lead author has to make sure that it does not say anything that would be too far in one direction, not the other, but that is okay. At the end of the day, when I look at the Working Group One Report, I would not use it as a textbook, I

would not find it all that helpful, but also I do not find it says anything terrible. It is very much on the level of saying “We don’t know. There’s uncertainty.” I give an example in my testimony of how the Working Group describes what appears later in the Summary and it is like day and night. That is the problem. This came up recently. There was a kind of scandal. There was one group looking at the impacts of global warming and they had a guy called Chris Landsea. Chris Landsea is probably the leading expert on the statistics and history of hurricanes and he has written a lot of papers pointing out there is no obvious relation that can be discerned between hurricanes and temperature of the earth and no evidence that warming would increase hurricanes. On the same chapter committee was a lead author, Kevin Trenberth, and Kevin participated in one of these dog and pony environmental shows, in which he said “The hurricane season this year in Florida is a warning about global warming.” That is ambiguous. Is it due to warming, or is it an example: who knows? Landsea said, “How could you say that when the evidence says there’s no connection?” What Landsea realised, I think, was no matter what the chapter ended up saying, even if it said “There’s no relation,” it would be represented by Kevin, or John Houghton, or whoever, and it would be said that there is a connection. This has been the problem. You have this damn Summary for Policymakers, which ends up saying things that are rather different. They have a funny way of using language. For instance, apparently, maybe it has changed, the last time, but for the first two IPCCs there was an agreement that the Summary for Policymakers, which is not written by the scientists, it is written in a plenary session with NGOs and government officials, and so on, if it says something that is not in a chapter, the chapter can be modified. The way it is modified is interesting, at least what I have seen is. There will be a line thrown into the chapter that corresponds to the Summary. It is not that they pull out much of the rest but there is a sudden cognitive dissonance in the thing, and so their statement that the Summary is consistent with the text means that what is in the Summary can be found

somewhere in the text. They do not go on to say that sometimes the opposite is also found in the text. I do not know. I have this statement at the end that when language becomes foolish our ideas follow suit, and the reverse can happen. I think we are seeing that within IPCC.

Q147 Chairman: Listening to a great deal of your evidence, and maybe we are just coming to the end and I would like to thank you very much for what you have said, there is one question that comes immediately to my mind. If it is like you present it, why are governments spending this enormous amount of money producing all this stuff, because there are enough of us sitting round this table who have spent our lives trying to control government expenditure in our previous incarnations and there are plenty of arguments for not spending it. If it is anything like you say, why are they spending all this money?

Professor Lindzen: I will give you a semi-serious answer, because I do not know the answer. My semi-serious answer is that I have realised, over the last 20 years and in dealing with public officials and ordinary people, that the last thing in the world they want to do is dig into science, to deal with mathematics, read this. If they can avoid that by spending a trillion dollars, they will do it.

Q148 Lord Sheldon: I know you cannot give an answer to this question, but can you make a bit of a guess: how much do you think is being spent on this, the whole of this business, just a general figure?

Professor Lindzen: I think at least 25 billion, 30 billion at the research end, but then there is probably a smaller but not insignificant amount surrounding. By now I figure that well over 10,000 diplomats and bureaucrats are working on negotiating the various things and analysing them and working out the economics, and so on, so it is a growth industry, but I do not think it is terribly productive.

Q149 Lord Macdonald of Tradeston: If I can go back to the question of the observed half per cent against the modelled three per cent increase.

Professor Lindzen: Well, three degrees versus a half degree.

Q150 Lord Macdonald of Tradeston: Thank you. Three degrees; perhaps also the unknown factor that would have to be found. There was a science programme on our television here recently on global dimming, on 'Horizon', which said the fact that these particulates have been multiplying has led to global dimming, this was all revealed to us after 9/11. Could this be the unknown factor?

Professor Lindzen: It is an interesting thing. One of the claims, and I discussed this in the deposition, is that the models can simulate the past century and simulation is a very low-order activity when you have adjustable parameters. These aerosols you are talking about were a godsend to the models. The reason they were a godsend is two-fold. Even if you know the amount of aerosol you have in the air, calculating the thermal forcing leaves you with an uncertainty of about a factor of six to ten, because we do not know their properties very well. In addition, we have no records of sulfate emissions before 1964, so to match records before then you can devise ways of estimating how much you have. Between estimating how much you have produced, and some of these estimates are very weird, they have maximum production in the depression and minimum during wars, it is hard to figure, and the fact that you cannot calculate the radiative properties, it is completely disposable. There is even a name for it in the literature. The aerosol people say their ignorance is so big that it might be legitimate to plug aerosols into the models and tune the properties to make the models more nearly coincident with the data. That is called the inverse method. They do warn, in an article that I cite here, in *Science* magazine, that then to use those properties to test the models is circular, and it is.

Chairman: Thank you very much indeed. Really we are very grateful to you for coming and for answering our questions. Thank you very much.