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P R O C E E D I N G S

MR. DERVIS: Welcome you all very, very much. It's wonderful to see this room so full, and I know it's overflowing, and very warm welcome to the panelists, to all four of them.

We have a real outstanding panel Lord Nicholas Stern, Professor Stiglitz, and then we have a representative from the World Bank, Ian Parry, and then we have -- I got the wrong here. Then we have Adele Morris who is leading the whole day in a way, because this is a day of launching Brookings White Cooperative effort on climate and energy across all departments, all parts of Brookings. So it's a very special day, and thank you all very much.

Before introducing the panelists, let me just note that Lord Stern and Joe Stiglitz are co-chairs of the high-level commission on carbon prices. The commission is in turn supported by the Carbon Pricing Leadership Coalition, which was created by the World Bank.

Minister (inaudible) from France, who is co-chair of the CPLC, regrettably could not participate. She was trying to make it, but somehow the plane was too late to fit it in, but she sends her best regards and wishes of success.

Adele Morris is senior fellow in economic studies at Brookings where she directs the Climate and Energy Economics Project. She was a senior economist at the U.S. Congress, worked at U.S. Treasury as a chief natural resource economist, and also worked for Wayan as a lead U.S. negotiator on land use and forestry issues as part of the climate change treaty process. She held several government positions prior to that.

So, Adele, really warm thanks to you, because you took a lot of leadership, a lot of hard work to get us to this point today. Thank you very much.

Harman Parry is that the right name?

MR. PARRY: Ian.

MR. DERVIS: Ian Parry is principal environmental fiscal policy expert in the IMF Fiscal Affairs Department. Before joining the fund in 2010, he held the Alan Neese Chair in environmental economics at Resources for the Future. He calls the 2014 very important IM working paper, how much carbon pricing is in country's own interest, the critical role of coal benefits.

Over lunch this was touched upon. It's a global issue. It's a global public good. I think Nick Stern called the issues around climate once the biggest market failure in history, but there is also something very local about it.

To stress the local benefits, which have positive global spillover effects was your topic and I think is now today a very important part of world discussion and is very helpful.

Lord Nicholas Stern is IG Patel professor of economics in government and chair of the Grant and Research Institute on the Climate Change and Environment at the London School of Economics.

Since 2013 Nick has been president of British Academy. In addition to many other position, he co-chairs the global commission for the economy and climate. Sorry, I get lost a little bit in all the commissions that exist, but there are a few.

Nick was chief economist at the World Bank and at the EBRD. I had the privilege to have an office very close to Nick, so that's where we started to know each other. We knew each other from before, but we got to know each other better.

While at the U.K. Treasury, Nick headed 2006 Stern Review on economics of climate change. I think that really was a turning point in the whole debate. There was always a group of people who worried about climate, who knew about the issues, but the broad lead economics profession broadly defined, pretty much ignored it.

I do remember being part of a commission created by the World Bank. We had our first meeting I think it was in 2005 on long-term growth. There were very emminent people, ex-ministers, Robert Solow was a member, Nobel Prize winners, and so on.

We had a one-day meeting in New York on growth, and nobody, including myself, I mean, I was just as guilty as all others, mentioned climate and climate change, and this was 2005. So it's fairly recent that this has become really a mainstream topic in the economics profession and also in the geostrategic sphere in politics.

I think Nick -- the Stern Review the way it's called was the turning point. It was the moment when the profession started really focusing on the issue with very controversial articles on this country and things like that. I'll come back to that for a minute.

Nick has written a new book. His latest book is "Why Are We Waiting? The Logic Urgency and Promise of Attacking Climate Change." So, Nick, thanks a lot for being here.

Then Joe Stiglitz needs absolutely no instruction, but he will still get some introduction. Joe has been active on this for years and has joined forces with Nick in heading this commission. He is professor at Columbia University and also the chief economist of the Roosevelt Institute.

Among his many position, he's cofounder and co-president of the initiative for policy dialogue which helps emerging countries, developing countries in their policy dialogue with the rest of the world. It's just those countries, right, it's restricted to the emerging and developing countries. He also co-chairs the OCD's high-level expert group on the measurement of economic performance and social progress.

Joe was a chief economist at the World Bank and at that time he was my boss, indirectly at least, and I have very fond memories of that. Also he headed U.S. Council of Economic Advisers. He was awarded the Nobel Prize. He's Nobel Laureate of 2001 in economics.

Joe has written widely on globalization, inequality, growth, development. I think it says here much more and I think that's a good way to put it, because if I start continuing, it will take quite a bit of time.

His most recent book is "The Euro: How A Common Currency Threatens the Future of Europe." We've had some discussions on that book. I haven't read the -- I read bits and pieces, but I'm glad to report it's not what I would call an anti-Europe book or anti-euro book, but it contains some constructive suggestions of how to salvage the project, and salvaging the project means a lot in today's world, due to strategically for including for energy and climate questions.

I just realized this morning that the U.K. had declared elections in June, June the 8th. Next Sunday are elections in France. The German elections have to be held before the end of September, and the Italian elections will have to be held in November at the latest, perhaps earlier.

So we have the four largest and founding -- four largest, three of them founding members of the European Commission, European Union project really having elections at the time when the U.S. just had its own election, very momentously important elections and where the debate on energy climate growth, the future of work, unemployment, and development are very big topics and they're all interval.

I don't want to take too much time, but I do want to kind of briefly explain how I came to the topic and I think how many economists got to the topic.

Of course as a caricature of -- wrong caricature to start with, but as a caricature is you have a multi-sector growth model with production functions, demand functions, constraints, and so on, and objective function, which you minimize, which is weighted -- some of the weighted by time, some of the income where you can weight it differently but by some kind of income welfare or economic satisfaction in the objective function. That did not usually include environmental sustainability, per se, or environmental quality of life, per se.

Also these models didn't have carbon as an input. Therefore, the whole climate issue was not part of this model. I think the early discussions were very simplistic in a sense, but naturally because that's where growth theories kind of came from.

You introduce a new constraint, namely a carbon budget of some sort, with new input into production functions, which cannot be used in an unlimited way, because it has some negative effects on production, consumption, quality of life, and components of the welfare function.

So when you introduce a new and binding constraint into multiyear growth model, be it the linear growth model or nonlinear model, you have first of all a shadow price for that constraint that emerges. Second, you lower the objective function. In other words, there is a cost. You cannot introduce new constraints and not have cost.

A lot of the early debate was about the size of this cost, the distribution over time, and also distribution over place. It took the profession quite a while to start thinking of it somewhat differently, and nobody contributed most of that I think than Nick and Joe did.

What's missing from the simple model learning effects, endogenous technology changes which are brought about by the price of the scarce -- the newly scarce input. Also what's missing is the fact of the incentives, not just the learning effects, but the incentives that future prices have on today's -- are in the expenditure and today's investments. Because these are very long-term investments for many of them, particularly energy and urban, which together account for a huge amount of the carbon we're talking about, it changes the whole nature of the problem.

The other side of the debate is regulation versus prices, but that in a way is less essential

I think to realize that the original kind of framework that economists have in their mind was missing this very important technological learning and projection effect.

I'm still sometimes surprised when corporations who are really hard players when it comes to profit maximization and so on seem to be behaving in a way that is much more, how shall I say, socially benevolent, not all of them of course, but many of them in the area of climate and energy.

I think another thing that has changed, I don't think there's agreement in the science on exact numbers. There are always ranges. Nick Stern has taught me that. These ranges are probabilities if you keep global warming below two degrees Celsius over preindustrial times, this is what you -- the range of temper of emissions that is compatible with and so on.

But what is now becoming I will say as certain as one can be in science in general, because nothing is hundred percent certain, but it's very, very high level of certainty is that there is in fact a cost. This is not a figment of the imagination, that it is linked to human activity, to urbanization, to energy, to forestry, to land use, and so on, and that sometime in the not too distant future this cost will become substantial and some of them we are already observing today in some areas.

There's debate as to how much is due to climate change versus how much is due to cyclical phenomenon. There's not a wide agreement -- full agreement on what is caused exactly by what.

But I think 95 percent of people who have at all studied the topic and thought about the topic far from being experts know that in the future there is going to be either a shadow price in terms of regulations and so on or an actual price of carbon. That I think has led to a major shift in the behavior of the private sector.

Because if you know that this is going to happen in the future, even if you don't know the details and the amount, there is a very real incentive to change your behavior now and there's an incentive even to be first mover.

If you can develop technologies that reduce carbon emissions and protect climate more rapidly than others, your profits are likely to go up and you're able to compete much more strongly against your competitors who have not done this and who have not realized that.

So when there's huge amount of uncertainty in terms of the exact numbers and the exact paths, there's very little uncertainty of the direction we're heading for. I think this is the paradigm shift that

has taken place from the simple linear programming model or nonlinear programming model, where the whole emphasis was really on the discount rate you put in the objective function.

There were many, many articles debating the size of this country. That's a part of the story, but it's become, in fact, much smaller part of the story. The bigger part of the story is the learning effect and the possibilities, the incentives, and the market effects of knowing that something like that is going to happen.

So I thought as somebody who's not in the field, who's not studied this in great detail, but as an economist that was my kind of intellectual journey so to speak from where I am today compared to ten years ago where I thought the discount rate was really the critical variable.

Last point, shadow prices are important. The prices, actual prices, are better and they will guide resources more surely, but if people have some confidence that shadow prices reflect future likelihoods, then shadow prices can influence behavior right now, even if there isn't an actual price.

So, anyway, these were some of the thoughts that I wanted to express. I hope that we are at the turning point here, and I do agree with those who say that the U.S. has to be absolutely part of it.

I don't think one can move this forward very much without U.S. and U.S. broadly defined. I just don't mean just federal government, but American cities, business, NGOs, and so on and so forth, because then the gaming aspects of the whole story become very negative. In other words, everybody waits on the other to move. With the U.S. being the strongest and by far the most powerful country and also in terms of GDP market prices still the largest economy, it would be very hard to move very much forward without U.S.

So I very much hope that U.S. will remain as it is now, not only part of the Paris Agreement, but also in terms of behavior. Some of the best technologies that are being developed, some of the best examples that are being set are actually set in the U.S.

So building on that, I think there is a lot to hope for, but I do believe the story is complicated. What Nick and Joe are great at, among others also, is to simplify it in such a way that the average citizen can understand it.

Because if it's not understood, then a future danger is something that people tend to

ignore or don't want to think about.

With these words, I'll ask Nick first and then Joe to make a small presentation, about seven to eight minutes or so each, and then we'll all sit around here and start debate -- kind of panel debate, which will bring the audience after the first few questions to the panel itself.

But thank you, and I also have to single out one more person, probably many more person that I'm forgetting, but one more person, my colleague, my friend, Amar Bhattacharya, who has worked relentlessly to make this happen, to bring the various pieces together, to bring the various organizations together, private, public, municipal, federal, and whom I think quite honestly all of us who are interested in this topic, we owe Amar a lot. So thank you Amar, thank you very much.

Nick, I cede you the chair here.

(Applause.)

LORD STERN: Thank you, Kemal, for a very thoughtful introduction, which raises a lot of questions which I hope we'll go into in the discussion.

But at a very headline level, what you were describing is dynamic public economics, dynamic public economics, public economics as if time mattered. Pace urgency is the essence here, because it's the cumulative total of emissions that counts.

Public economics in the sense that people's learning, people's understanding of issues change. Indeed public policy should think about how to induce changes in that learning. Dynamic public economics in the sense that any kinds of evaluations of gains in the future versus gains now are going to depend very strongly on how well off you think you might be in the future relative to how well off you might think now.

So anybody who talks about the discount rate, goes straight to the bottom of the class. Because what matters is that there are many discount rates, depending on not only obviously the good that you look at but also what kinds of circumstances you imagine for the future. Those are, if you excuse the words, intensely endogenous. The risks we run depend on what we do now.

So all the things you raised, Kemal, at the heart of this story and just as a headline, it's about dynamic public economics. We have to learn there's not going to be one model that's going to drive dynamic public economics, but they're going to be a range of careful arguments, some of which

involve explicit models that are going to drive that story through.

Joe is going to say something about that after I'm done. Because what I'm going to try to do is move very quickly through where we are now. It always makes me laugh, but it's a high-level commission on -- now, you wouldn't want to be a low level commission -- anyway, that's who we are.

We were invited, Joe and I, to chair this commission by Segolene Royal and FICA sebenza and through other co-chairs of the Carbon Pricing Leadership Coalition. We've had the real blessing of a very strong secretariat with John Rhume and Stephan Holgate and Salene and others involved and we're very grateful to them for all the work that they've done.

Thank you again Amar and Adele and Brookings for your support and advice and guidance. Of course, Adele is part of the commission.

So that's the commission. I won't go through all the names. I think they're on the last slide anyway, which I'll leave up. They go from Mali, to China, and Brazil, to Chicago and so on. It's a very broad -- but nobody represents anybody other than themselves.

So that's the commission, that's who asked us to be a commission. So let's start with the question -- I used to attend Nicky Caldore and Joan Robinson's lectures in Cambridge in the 1960s and Joan Robinson always thought it was original to say what's the question, but it doesn't matter what is the question.

So our question is: What kinds of pricing structures varying over space, varying over assumptions, varying over time that we talk about corridors prices, what kinds of prices coupled with sensible, reasonably wise other policies?

We also ask the question: What prices do you need? Not so wise, but what kind of prices could be expected to induce changes in emissions through behavior investment and so on consistent with staying well below two degrees?

So how do you use prices to deliver on Paris in shorthand is what we were asked to do. It is important -- note that expressing it that way indicates straightaway that we are not examining or discussing the social cost of carbon as measured by the kinds of social damages that an extra ton of carbon would bring to the world. That itself, of course, is enormously dependent on what kind of path you think you're going to follow for the reasons I've already discussed.

That's not where we are, but we observe in the appendix that because most modelings of the social cost of carbon, most modelings used in the estimation of social cost of carbon leave out so much of what really matters in terms of risks that one can say that whatever numbers they come up with, they are very serious underestimates of what that might be.

We leave the question there and we put it in an appendix, because it wasn't the question we were we were asked, whatever the interest in that question. There is an interest in that question, but that's not the question that we had.

Why we don't dissect the Paris Agreement and wonder too much about why people did it and whether they should have done, I actually think they did it for very good reason.

Just this one slide here is why did it come about. Well, obviously an understanding that these risks of climate change, even though you can't be precise, were potentially immense, existential for many.

The promises put on the table in terms of the nationally determined contributions, the indications of where countries would be in 2030 on their current plans where they try to do something for this challenge, fall way short of what's necessary in terms of reductions for two degrees or well below two degrees.

So a recognition of why it matters, a recognition that we're falling short in terms of current plans as embodied in the Paris Agreement, a recognition that this involves very radical change, the world economy will double in the next 28 years or so, infrastructure will more than double. In that time, we have to reduce total emissions absolutely by about 20 percent.

So that's an indication of just how big these changes would have to be. But many of us take the view they're feasible, they're exciting, they're attractive, they bring other things with it. Not only is climate policies have done well consistent with growth and development and (inaudible) reduction, but there is potentially, if we're able to realize it, a rather attractive growth story there, a kind of growth that is much more attractive indeed than that which involve cities where you can't move and breathe and the ecosystems that collapse.

So that's enough on why we did it all as a world, and we did do it all as a world, nearly 200 countries in Paris in 2015 and the agreement applies to everybody.

We start also with a clear understanding that economic incentives matter. No matter how much you go on about market imperfections, and we do, because they're important, not just the imperfection in the greenhouse gas externality but also around capital markets, networks, R&D, and learning, clearly market imperfections there.

Given all that, it is still true that prices ever very important incentives and a carbon price is very important incentives. It is obviously deeply mad to pursue fossil fuel subsidies in a time where you ought to be increasing carbon prices.

Also we take a reasonably broad view of the carbon price and recognize that shadow pricing in public sector activity can be very important and internal pricing in firms can be very important.

We don't dwell on those. We do note and emphasize their importance. We're talking mostly about carbon prices.

So carbon prices are at the center of the story, although they're not the only thing at the center of the story of inducing change on the scale that's necessary.

Packages will come together. I've already indicated other important externalities, such as R&D networks, capital markets, and of course the immense potential co-benefits of reduced pollution.

So they will be part of packages. Those packages will vary across countries, because the challenges in different countries are different, the endowments in different countries are different, the price of complimentary resources are different. There's all reasons why policy package to induce the kind of change that we're talking about would vary across country.

At the same time, support from one country to another, and it doesn't have to be all one way from rich to poor countries, but that will be a big part of the story. International cooperation and support will be very important in this story, and the overall efficiency globally of carbon reductions is important.

The ability to make the very big investments that we're describing here can involve, would involve, economic support in some circumstances.

Having set that up in terms of what question we're asking about carbon prices, why other policies will matter, but what are our lines of evidence on what those carbon prices could be?

Well, one is to look at what kind of prices given what we know, given what we might

anticipate about technologies, what kind of prices could induce a switch, and there's quite a lot of evidence now on that.

The second body of evidence has been quite a lot of detailed studies, deep carbonization pathways was one of those, but quite a lot of national studies about what's involved in my own country, United Kingdom, the climate change committee looks very carefully at what kinds of changes might be involved. Embedded in those stories will be some carbon prices.

The third route is the rather global integrated assessment models. They can be helpful on their -- in terms of looking at coherence across different assumptions across the world, but they suffer a big defect in the sense that they can't easily cope with learning, which is at the heart of the story and they can't easily cope with economies of scale.

It's one of the really big problems of general (inaudible) modeling ever since -- for a very long time. Dealing with learning and dealing with economies of scale is very hard to put in close models. Sometimes it doesn't matter all that much. This time in this context it matters enormously, so they're the third, not the first of the places that we go.

Now, what about the pattern over time? Well, there's quite a lot of difficult issues involved in the pattern over time. There's the simple sort of telling story of the optimal exploitation of natural resources, which looks at discounting over time, it looks at rising marginal costs as you try to extract, and those have some relevance here and point to rising prices over time.

But learning is very important. How do you introduce strong learning? Learning is at the heart of the story. How do you give a clear strong signal that this really is the direction that you're going in?

Well, one answer to that question would be to bump up prices quickly and strongly and people will really see that there's a powerful incentive, another way around would be to promise to have prices rising over time so that people see an incentive that way. You can argue it both ways.

I tilt a little bit toward the former, because telling people that prices are going to rise steadily over time and then having lots of people lobbying you so they don't is a scenario that you can imagine. Being a European, it's a scenario that we've observed.

You can tell those stories either way. But in thinking about prices over time, you have to

think about the hoteling, rising marginal extraction cost of the argument, you have to think of learning and economies of scale kind of arguments, and you have to think of bringing people with you, and credibility stories as well. They all count and you have to think about those things. It's not one formulaic answer to increasing over time and where you start.

I think we inclined a little bit to the story that you have to move strongly now, because we're so far away from where we need to be and then move upwards over time.

Having said that they vary across places, I think it's important to recognize that the signaling efficiency role of prices is an important one. If the word as a whole does all this well, you might expect a few decades from now to see carbon prices starting to come into toward a common value.

Now, what do you do with the money, well, it depends where you are. In some places, taxation is a word that drives people to throw tea into harbors and that sort of thing.

In other parts of the world, people think of it in essential elements and responsible states that has lots to do to invest in education infrastructure. Opinions vary. You can see where I stand.

But the -- you do have to ask what to do with the revenues, because you do. It is important. You can just use it to pay down the debt, if that's what you want to do. You can't leave that question completely hanging. So once we don't as it were major on that question, we don't point out the different possibilities and suggest in different circumstances they'll have different attractiveness, so you wouldn't expect all countries to do the same thing.

Reducing other taxes, particularly distorted taxes, particularly in a progressive way, if you can, would one way. Helping to manage the change in terms of poor people or managing vested interest. You sometimes think vested interest don't deserve to be managed, but you do have to. That's a fact of life and that's a story which you can't discard. Of course R&D and learning are terribly important in this whole story, as is investment and infrastructure. And sustainable infrastructure is at the heart of all this, as I hope I made clear right at the beginning.

Complimentary policies, well, I've already alluded to the many other market failures, which are fiercely relevant in this context. But in this slide here, we emphasize what those other policies might be. I won't go into all the detail.

Efficiency standards are in the land and forest management trying to get capital markets

to cope better with risks in the longer term. Critically important here, because high cost of capital not only deters investment as a whole, it changes the nature of the investment, because many of the more renewable technologies have capital up front in order to save on running costs down the track.

So the cost of capital is a fundamental importance here, and there's a great deal that can be done about that, particularly in my view with the amount of natural development banks.

Those are the things which come as it were with carbon pricing. Again, different policies will make different choices here, but there they're very powerful good solid economic arguments for putting a package together, which deals with not just the big externality of greenhouse gases, that market failure, but the other relevant market failures as well.

The lower is your action outside the carbon price. The higher generally the carbon price would have to be in order to deliver the reductions.

So what are the conclusions, well, the -- I'm not going to tell you what carbon prices we come up with. But you're intelligent people, so I'll give you some clues as to where we might be going.

First, we know that current promises on the table in nationally determined contributions are together for 2030, in the Paris Agreement, are together far too low. Paris was very honest about that.

So I said, we reconvene starting almost now, starting next year to get together to work out how we can ramp up. Examples of good policies are going to feed into that kind of discussion, but we can say we are as a world far too low.

The 2030, the Paris nationally determined contributions point to an increase from about 50 billion ton sale to equivalent now to 55 or more in 2030. In other words, the Paris promises on the table are around the 10 percent increase or more over the next 15 or 20 years. We actually need a 20 percent decrease. So that is for the Paris target itself well below two degrees. So that is an indication that we have to ramp up if pricing policy is, as we believe it is central to that, is pretty clear that we're going to conclude that carbon pricing should be a lot higher than carbon prices now, which are ballpark on average $10 a ton CO2 or less.

So it's clear that there's going to have to be a ramp up in policy around, including in carbon prices. But we also make the point that they won't be the same everywhere, they'll vary across countries, and they'll have to rise over time. That's why we will be thinking of corridors where there's a

range. If you have very weak complimentary policies, you might expect prices to be at the top of the range and so on.

So that's the kind of story that we'll be telling. We'll publish in about a month and then you can read it all and write all about it. But we'd love your thoughts, because it's not -- it's well advanced, that's why we're talking to you, but it is not finished. So your thoughts on how we express ourselves, what we should say would be enormously welcome.

Let me just make one last point, which I perhaps haven't emphasized strongly enough. Whatever prices you come up with, credibility is going to be very important. We're talking about investments that take ten -- that might take tens -- make take decades to look -- in their lifetimes.

So where prices are going to go is very important. You can't offer people certainty. The world is not like that, but you can try to work to reduce uncertainty and the credibility of prices will be very important. And we learned a bit of about that. They're all of institutional structures.

Not to bang on about my own country, which is not in that brilliant of state, but it does have climate change legislation and a climate change committee, which helps as it were, and it looks for targets 15, 20 years down the track. It monitors as to how well we're doing.

Those are kinds of institutional frameworks that can give you confidence, presence of Multilateral Development Bank and also give confidence.

So to say that nobody can give cast iron promises is not to say that we can do nothing about credibility. There's quite a lot that we can do about credibility.

Let me leave it there. I first began working with Joe when we were walking around in Kenya in 1969 arguing about growth theory and capital theory and so on. It's been one of the great pleasures of my life to be working with him ever since. Thank you.

(Applause.)

PROFESSOR STIGLITZ: So thank you very much for inviting us and giving us this opportunity to talk. We're only about a half-hour late, so I'll be -- try to be a little brief in my remarks. That's always a mistake for me to say that, because I'm never brief. Nick has covered most of the issues. Let me just sort of reiterate a couple points that he raised.

The first was that this is a dynamic process, dynamic public economics, and one way to

bring that home is I first became very deeply involved in these issues in the early '90s when I was on the IPCC panel that looked at climate change. The only mistake that we made in our assessment, the second assessment, was that we under estimated the seriousness of the problem.

To give you an example, though, of a caution that we had was that we were pretty sure that one of the aspects of climate change was not just an increase in temperature, but also weather variability but the evidence was not sufficiently strong for us to make a strong statement about weather variability. Since then, the evidence has become overwhelming, and now subsequent assessments have emphasized that.

But if you looked back both where we are today 20 years -- a little more than 20 years later -- 27 years later, things have changed so much that it's clear that one could not have solved an optimal dynamic programming problem in the absence of uncertainty and gotten anything right.

Solar costs have come down far faster than anybody would have anticipated. At the same time, climate change has proceeded far faster than most people had anticipated.

Since the IPCC was dominated by real scientists, not by economists, we were very sensitive to the uncertainties in which we were engaged and it was very much part of how we framed it.

One other thing, just to comment on, is even then, as I say, it was so clear that it was important. It was enlisting some of the most talented people in the world. One of the coauthors of a chapter that I wrote for that report was Kanero, who is one of the great thinkers of the last hundred years. We wrote a chapter on how do you deal with uncertainty.

So it was clear that this was going to with us and that there was a lot of uncertainty, and, therefore, when asked to think about policy responses within that context.

So just three other points. The first is the fact that one -- that addressing problems of climate change can be done in a way that is totally consistent with maintaining robust economic growth.

This is obviously particularly important for developing countries, because they need to catch up. But it's also true for developed countries like United States, which are performing very anemically, so I worried about it.

So we are very convinced that one can approach the issue of addressing climate change in ways that are pro growth. Of course that highlights the importance of doing -- addressing a problem in

an efficient way, and carbon pricing is an essential aspect of addressing climate change in an efficient way.

But one of our senses was -- very strongly is it's an instrument that is very important both explicit pricing and implicit pricing and the use of pricing cost benefit analysis, the use of pricing internal to the firm, but that it will have to be accompanied by other instruments.

There are a whole range of other market failures, market failures, a whole range of concerns like distribution concerns that need to be brought into the analysis, and that -- therefore, while carbon pricing is absolutely essential, it's not the only instrument.

The reason why one needs to take that on board is to make the changes necessary to get down to essentially zero emissions is going to take very large changes in the structure of our society and the structure of our economy. It's going to change not just in the way we produce electricity, but also -- in transport, but how we arrange our living and our work.

Much of that occurs in the public sector through DEC decisions about infrastructure. Much of that -- so broadly our report addresses the major transformative changes that will have to be necessary.

It's not the old debate about regulations versus prices. It's really regulations and prices that when -- both of these as important instruments for going forward.

The final point I'll make is that I hope that our report will help develop a consensus behind the use of this important instrument of carbon pricing. There's a lot of NGOs, a lot of people have been working on this a long time.

I think this may be the moment where we can finally push successfully so that we will have things like carbon taxes and carbon pricing used throughout the world, throughout our economy.

But when that happens, it's important that there's a broad sense of what those carbon prices ought to be, what are the ranges, not a single number, but a range of numbers. Hopefully our report will help provide a focal point for the international community to start thinking about what kinds of prices would generate the beginning issue that Nick emphasized, what kinds of prices would generate the kinds of -- elicit the kinds of responses that would enable the world to achieve a goal of two degrees maximum increase in temperature of one-and-a-half degrees. That goal we should keep in mind and this

is an important instrument for achieving that goal. Thank you.

(Applause.)

MR. DERVIS: So, Ian, to get the ball rolling at the IMF you increasingly focused also on this issue in terms of global macroeconomics, but one thing that is part of that is the distributional affects that may lead to not nationally also, but also internationally.

Maybe you can say a few words on that, because it's part of -- it's part of the difficulties reaching an overall path, which the world more or less as a whole can kind of coalesce around.

MR. PARRY: Right. We emphasize that when countries are trying to move ahead with carbon price, we should emphasize the opportunities, the potential revenues, which we would put at about one to three percent of GDP for the typical G20 country moving with phasing in carbon prices around $70 per ton by 2030, so that creates a large amount of revenue.

Much of that can be used for growth enhancing measures, like cutting taxes on labor and capital or on funding spending -- productive spending like infrastructure, but it's also important to address the sensitivities, the impacts on vulnerable groups.

Here we've been looking at the incidents within a country of carbon pricing, and our analysis suggests, for example, in the United States and in China that carbon pricing would be a moderately regressive, meaning that it imposes a slightly higher burden relative to consumption for lower income households than higher income households, but we found the opposite in India.

Another important statistic is you really want -- we emphasize that holding down energy prices below their efficient levels, and efficient means not only covering production costs, but also environmental costs, air pollution costs, and climate costs, that's a terribly inefficient way to help low-income households, because a huge bulk of the benefits typically 90 percent or more accrue to higher income groups.

But as you do reform energy prices, as you phase in carbon pricing, you do want to help the low-income households. Typically, at least in the early phases, we estimate that you'll need about say eight to twelve percent of the carbon pricing revenues to compensate the low-income groups.

MR. DERVIS: Internationally?

MR. PARRY: Well, this is argument about shouldn't the advanced countries take the

main burden of mitigation, and clearly there are arguments for that.

But we still think it's very important for emerging market economies to be pricing emissions. For one thing, 195 countries -- well, it's 194 now. A large number of countries have made these mitigation commitments and they want to meet these commitments at lowest cost burden on the economy. The best way to do that is to have carbon pricing at the centerpiece.

For a lot of emerging market economies, they simply can't raise sufficient revenues from broader fiscal instruments because it's such a high concentration of economic activity occurring in the informal sector.

So from a fiscal perspective, it does make some sense for them to include carbon pricing as part of their broader fiscal system. Then in addition, for some countries like India and China, there are very large domestic environmental benefits from moving ahead with carbon pricing.

We estimate if China phased in a $70 per ton carbon price between now and 2030, that would save about 4 million lives over this period due to less exposure to local air pollution.

So for a lot of these countries, it's actually in their own interest to impose some level of carbon pricing, because of the domestic environmental benefits and possibly the fiscal benefits before we even encounter the global climate change benefit.

When we're discussing equity issues and burdens on different countries, we emphasize it's very important, not to just look at the pure economic costs of mitigation, but subtract off the domestic environmental benefits and also (inaudible) benefits as well.

MR. DERVIS: Adele, the U.S. in all of this now, the big question -- one of the very big questions: What are the two or three points that you perhaps like to make in that context?

MS. MORRIS: Thank you, Kemal. First of all, thank you so much for chairing this event. I'm just delighted at your leadership on this topic within Brookings and more broadly, and I want to thank Nick and Joe for their leadership on our not so easily managed commission.

I think you guys have done an amazing job. In part due to the terrific support from the folks at the World Bank, so thank you, John Rhume, and your team for all their hard work.

So far the Trump administration has not yet invited me to come brief them on my views as to what the U.S. ought to do, so I might as well just brief you since you're sitting here and you all look

so bright and I'm sure you have a straight conduit to the White House inner sanctum, so you can take advantage of my thoughts as you see fit.

I have two pieces of advice to the Trump administration and to Congress. Number one, stay in the Paris Agreement. I think that there's -- the U.S. -- I strongly agree with Secretary Tillerson. The U.S. needs a seat at the table. There's no substitute for U.S. leadership and participation, not just in that multilateral fora, but in the G20 and the other multilateral discussions that include all sorts of economic and national security matters and -- of which climate is an important element.

The other thing I would say is put a price on carbon. The topic of our event today is Carbon Pricing In the Future of Global Climate Cooperation. I could say carbon pricing is the future of global climate cooperation in many ways.

I would love to see the administration take an extraordinary opportunity to set the climate agenda for this country for decades to come. I think it's an extraordinary opportunity.

I tell you a couple reasons why, like economically why and politically why and then how I think they can do it, so you can decide if you believe me.

So let's start with the politics, because we understand this is a very changed political environment in the United States. So why would it be in the interest of the Trump administration and the Republican Congress to work with Democrats on this topic? I would say number one, obfuscating and dissembling on climate alliance is a losing strategy. It's a losing strategy for sure in the long run. I think increasingly it's a losing strategy in the short to medium run politically.

I think we see that in terms of the views of young Republicans and the views of Moderates, Centrists, Independent voters, and increasingly Republican voters as well.

I don't think the Trump administration is going to be able to deliver on the promises it has placed with regard to the outcomes of environmental deregulation. You kill the clean power plan, change up the methane rules, walk back from some of the Obama era regulatory programs, you're not going to bring back coal production in Appalachia. Look at the data. Look at the forecasts. I run these models. It's not going to happen. So how are you going to deliver on a better future to coal workers and their communities? I'm going to get to that. I have the perfect answer for you.

I think it's an opportunity to show you can make a deal and have a success and work

across the aisle and really truly address one of most critical problems facing humanity, and be a global leader, be seen to be the global leader that the Trump administration can be if they choose. I think this is an opportunity in the palm of their hands, and at the same time accomplish other goals.

If you want to work the carbon excise tax or call it a fee, whatever you want to call it, fine with me. Is it paid for into corporate income tax reform or some other broader tax reform, great. You want to do a standalone fee and dividend bill, great. But you can accomplish those other goals while still serving the environment. So, those are a few political ideas.

Let me give you the economic rationale for U.S. leadership in carbon pricing. First of all, being the biggest market economy on the face of the earth, having the deepest, most liquid, most dynamic, most efficient capital markets on the face of the earth, we have capital ready to be deployed in the R&D and the technological -- we can be the engine of innovation, but we have to have the profit motive harnessed appropriately and that's what you get when you price carbon if you do it responsibly.

We've got the scale. I really believe that one of the most important conceptual framing of how we price carbon in the United States is how do we create the perfect crucible for forging the technologies that will then be adopted by countries with less means than the United States, and those positive environmental spillovers could swamp whatever we manage to accomplish domestically in terms of emissions abatement.

What would that package look like, so I think we need the carbon price, again put it in tax reform. I think we need to be mindful of the effects of those disproportionately burden.

Ian talked about that and I think that's true in the United States as well. Many of our social safety net programs are price indexed, so to some extent those who subsist on transfer income will be a little bit buffered, but we still need to be mindful about low to moderate income households that would have some real new net burden from a carbon tax.

I want to come back to the coal workers. Just a tiny slice of a reasonable carbon tax could be transformative in coal country. Underwrite the pension and medical benefits of coal workers and retirees in industry, it could fund reclamation of disturbed and impaired lands and waterways.

As a result of coal mining, we could invest in infrastructure. We could invest in the education and the brighter future for people who live in coal country and whose -- generations have

depended on the industry. So those folks could be made better off than they would be even without climate policy; right.

So you did this right, you've got so many opportunities for leadership, environmental effectiveness, and program tax reform. What's not to love about a positive agenda that way.

MR. DERVIS: Thank you very much. Joe or Nick, would you like to react very briefly to either one of the --

PROFESSOR STIGLITZ: I agree with them. I can say -- put this in, just for a minute, into broader optimal tax theory. Optimal tax theory always took into account, when it's done right, distribution effects, so you can think about it in those terms.

The taxes that you would impose would be sensitive both to the distribution effects and how you could undue those distribution effects.

As Adele pointed out, if you have welfare support programs that actually compensate them, then in some sense -- it's more complicated in that in the sense that in certain parts of the country, for instance, those effects will be larger than others and we don't have sensitive programs that pick that up.

But if that were found to be significant, we could obviously deal with that problem. It's used as an excuse. It's not really a legitimate reason not to go ahead.

MR. DERVIS: But is one other reason that the U.S. is questioning is the country distribution of the commitments, international commitments?

MS. MORRIS: I think the concern that China is not doing anything; therefore, why should we? I think that's mostly BS. It's a smokescreen for not doing anything. In fact, China is doing --

PROFESSOR STIGLITZ: Yeah. Nick and I spent a lot of time in China and I think both of us would say they're actually very committed to it. When a -- the new Development Bank that they are one of the five members is committed to -- the whole focus is on climate change.

MR. DERVIS: What about India?

MS. MORRIS: Well, India has now a tax on coal. This is sort of -- people don't realize it. We have a little tax on coal. It funds our Black Lung Disability Trust Fund. So when India adopted a small comparable tax on coal. After hectoring the Indians for years to do something about climate, they

finally adopted tax on coal and the U.S. doesn't say anything, that's sort of unfortunate.

Then they raised it and they're raising it again. So little by little by little I think the Indians have come to realize, number one, they have a terrible air quality problem. It's not just a human health issue, it's a political issue. I would say that's true in a number of developing countries, not just India.

I think that we should be developing international dialogues and fora to talk about these policies and reward and applaud each other when we do make progress, exchange ideas, and techniques and administrative tools and develop methodologies and agreed reporting standards and monitoring approaches around carbon pricing, per se.

I think that's another great area of right for leadership, whether it's the Trump administration or those in the carbon pricing leadership area, there are a number of really promising areas of international cooperation and coordination.

MR. PARRY: It's true, though, abodement, the pledges, are kind of all over the place. Effectively some countries have to cut emissions below business as usual in 2030 by 40 percent. Others don't have to do much, maybe cut emissions by 10 percent.

According to our very rough estimates, just based on plausible assumptions about fuel price responses, if G20 countries were to phase in a $70 per ton carbon price by 2030 that a bunch of countries would easily meet their mitigation commitments, Indonesia, China, India, South Africa, and so on.

Some other countries would just about or slightly fall short of their commitments, United States, Japan, Germany, whereas others poor old Australia and Canada would fall well short of what's needed.

At the moment, there is a wide range of implicit or explicit carbon prices implied by the commitment, but the idea is that countries will be revising these commitments over time and presumably there would be a lot more pressure on countries for whom it's relatively easy to meet their pledges to ramp up their commitments relative to those that are really struggling to meet that commitment. I would imagine...

MR. DERVIS: Just to clarify, when you said 20, you meant CO2e, right, for when we talk current prices, it's carbon monoxide equivalent?

LORD STERN: Yeah.

MR. DERVIS: It's something that in numbers appear can create confusion.

LORD STERN: Could I add a little to what was said about China and India, because I think it helps understand both about why Paris happened and where we might go.

The first question, can I say something briefly about what Ian and Adele said, yes, I agree and I thought it was elegant and convincing. So what about China and India, China has probably -- China peaked coal probably 2014, coal years, and China may well have already peaked emissions.

They promised to do it by 2030. Print forecasting they'll do it in the early 2020s. I think that probably was a bit too late. I think it would be before 2020. That's a measure of how fast they've changed and how they're over delivering on Paris commitments.

It's a Chinese characteristic in planning is that you don't commit until you think -- unless you think you can really do it, which not a perspective on targets which everybody has.

China doing it for reasons are going to stay. They're deeply worried about climate change. For millenniums water has been a big, big issue in China. The water comes mostly from the Himalayas. They're a coastal population. They're very vulnerable to sea surges salinization, sea level rise, so they really worry about climate change. The Politburo is full of people who have serious science degrees.

Again just (inaudible) from other kinds of cabinets. There are other aspects of Chinese policy, which we can discuss too, but I'm making those observations.

Certainly pollution is a very big part of China's story, but also they feel that they in this new race in technology to get cleaner technologies, build better infrastructure, more efficient infrastructure, they think they can be rather good at that and they saw evidence that they are.

So these are reasons they're not going to go away. Chinese commitment is clear and strong and will continue. India -- China really changed around 2010 and it was 2009, '10, it was built into the 12th five-year plan, built into the 13th, and rebuilt into the next one too. Those are legally binding. They become law in China.

India, the change I've been working in -- working China for 30 years, India for more than 40 years, the change in India in the last three or four years has been remarkable. Again, it helps

understand Paris and why developing countries, merging market countries, were ready to make commitments in Paris.

Finally the pollution in Indian cities has become a political issue. Far, far too late since around half of the worst polluting -- worst polluted cities, said top -- or bottom 25, depending on the way you look at it, are in India and that is the worst.

That really has become a political issue. It's published in -- pollution is published in the vernacular press, you can see it now displayed in various parts of Delhi. It's really becoming political.

Second, the cost of solar and competitive auctions in India has dramatically reduced and is competing coal away. Latest energy assessments, as made by governor of India, indicate that they are unlikely to need all of the coal power under construction already. We'll have to see how that develops.

But that's been a remarkable change, so it's been a combination of pollution and the opportunities that they now see to do things differently.

So the drivers in China, I think are now kicking in quite strongly in India. The same will be true in many other parts of world. Remember in my own country, the UK, we kill 30 to 40,000 a year from air pollution, one in 2,000 of our population, at least ten times, perhaps 15 times more deaths than through traffic accidents.

So when we talk about India and China, we shouldn't think that those are the only places that suffer from air pollution and where these arguments are strong.

MR. DERVIS: Thank you. I think we'll turn to the audience now. Take a few questions, rather than one by one. Starting with -- just identify yourself, please, when you ask your question. I won't go directly back to the panel, but collect a few questions and please make it questions rather than --

MS. WERTHHEIM: I'm Mitzi Worthheim with the Naval Postgraduate School. I guess I have two questions.

What do you do about people who become unemployed because of this major social change, and how are you going to educate the general public in what I consider a clear concise compelling story, not for the educated, but for those who doesn't focus in on this, unless you make it something oh, my God, we have to do something about this? It's going to take a long time.

MR. DERVIS: Thank you. There was a gentleman in the middle there somewhere, I

think, with the beard there.

MR. KRAUSE: Hi, Don Krause with Citizens' Climate Lobby. If any of the panel members could discuss the benefits of or problems inherent with border adjustment tariffs or fees between countries that are pricing carbon or not pricing carbon. Thank you.

MR. DERVIS: The microphone is over there. Benjamin Schlesinger.

MR. SCHLESINGER: Thanks, I'm Ben Schlesinger. Adele, it's good to see you. I'm basically a natural gas exert, so I don't know, we're part of the solution I guess of replacing coal (inaudible).

So to your point, Adele, it's maybe more than money. I spent some time in coal country. It's effectively invalidating a way of life by stopping coal.

We all know the one thing you can do for coal in this country is to band fragging, and coal will fly as a result and usage would increase. That's not going to happen with this or any other administration.

So coal has been marketed out and it invalidates them. My daddy did this. My daddy's daddy this. So I think that's something you have to deal with. The lady who asked about bringing in -- explaining this and bringing a buy-in to people who are not highly educated as we all are, but people who simply have their views based on their way of life.

MR. DERVIS: Yes.

MR. TONGIA: Rahul Tongia with Brookings India. We heard about distribution in variance and carbon pricing and shortage of global market, which eventually, as you said, get to one price. We may have different numbers in different places and we, in fact, have different numbers, many zero, but many non-zero in different parts of the world.

How do you see that playing out, because is it not something that comes back to bite you politically or economically in terms of comparative advantage? How do you see that evolving?

Because, yes, we need much higher numbers as you've alluded to actually get closer to the two degrees or 1.5, but those who take that step are putting themselves out there.

MR. DERVIS: One more there. Yeah, then we'll take another round.

MR. BERMAN: Len Berman. Joe, I was surprised when you said you thought we

needed to emphasize that it was carbon pricing and regulation. Adele and (inaudible) argued that one of the appealing things politically in the U.S. is that you can substitute inefficient regulation with much more efficient carbon pricing, and I'm not really optimistic that even if there is an optimal regulation scheme that would work that we could ever get there, given the way we do regulations in the U.S.

MR. DERVIS: Maybe we'll take one more, because of the timing and then we'll have last round on the panel.

SPEAKER: A rather basic question. Brookings naturally is an economics institute, so the emphasis is on price and then we'll see how the world responds in terms of the actual carbon reduction.

The other way -- I took Economics 101 several decades ago, and the other part of the curve is you got the two curves that you all know from Economics 101. The other curve is the part of the quantity, that an alternative approach could well be to put requirements that absolutely demand reductions in carbon use in various everything, home industry, utilities, and then see how the world responds to what price is really required to achieve those things. Otherwise, we're guessing one way, the other way it might -- we'll be open and find the surprise.

MR. DERVIS: I think we'll take the last round now. Maybe starting with Adele and then ending with Nick. Please don't feel you have to address every question, but particularly those concerned with what you said.

MS. MORRIS: Well, let me take something that I've actually given a lot of thought to and I'm doing research on right now, and that's the issue of competitiveness and trade distortions that can result from disparate carbon pricing. So at least in the United States, I think there are at least five things we can do to ameliorate concerns about competitiveness, but first let's put it into context.

The actual amount of economic activity that would be displaced or the emissions that would be driven abroad as a result of a unilateral carbon price in the United States is very small.

Obviously it depends on what that price is and exactly how unilateral it is and what time frame you're looking at, but the fact is the vast majority of American activity -- economic activity is not going to be displaced as a result of a price on carbon.

But to the extent people are worried about it, and I know this is important, especially in energy intensive trade exposed industries, there are at least five things we can do. Some of which might

clash a little bit from what Nick and Joe said.

First I think we can start our carbon price modestly. It needs to be environmentally responsible, it needs to be credible, it needs to be effective, but I don't -- I'm pretty convinced that starting out of the gate with a very high carbon price would scrap capital, it would galvanize opposition, and probably be politically unstable.

So my own view is in the United States, we should probably start a little more modestly and ramp up overinflation and give everybody time to adjust politically and in their capital stock and households and corporations alike.

I think we can in the United States very specifically supplant a future of regulation under the Clean Air Act of greenhouse gases with a price on carbon.

We can do that environmentally responsibly, because those regulations will take decades to promulgate, and they're going to take an unceasing series of Democrats in the White House that we've already seen the vulnerability of that regulatory authority to a political shift.

So I think we're not giving up much, frankly, if we suspend the rule making process in favor of a price on carbon.

Third, we can use that carbon tax to fund progress tax reform that makes the whole U.S. more competitive. If you make the U.S. more attractive to capital and investment and saving, that can only be a good thing for U.S. competitiveness.

Fourth, I mentioned the diplomatic advantages of a carbon tax as opposed to many other climate policies. I don't know that other countries really knew what Section 111(d) of the Clean Air Act was and what it was going to produce.

California, God love them, have no standing under the framework convention on climate change. They can't make commitments on the part of the United States government in a sub-federal jurisdiction.

So there's clear diplomatic advantages and we should leverage that, because that competitiveness issue is very much directly dependent on what other countries do.

Finally, I think for those industries that are very energy intensive and very trade exposed and for whom the competitiveness issue is salient and immediate, even with the modest starting price,

you can have a carefully circumscribed border carbon adjustment and I believe such a policy can be made to be consistent with WTO obligations.

With those five strategies, I think we're good to go and concerns about competitiveness are not a reason not to do anything.

MR. DERVIS: Thank you. Ian.

MR. PARRY: Just starting with this issue of wide range of carbon prices emerging in different countries given different stringency of commitments and the difference in the emissions to -- responsiveness to pricing, emissions are a lot more responsive to pricing in coal intensive countries than countries that don't have coal.

We think it's time that our policymakers consider the possibility of complimenting the Paris process with a carbon price floor arrangement, particularly among the large emitting countries, so they would agree to impose a minimum carbon price and actually ramp it up over time as a compliment to reinforce other efforts to meet their mitigation pledges.

It seems to us a good way to go, because it provides some degree of assurance against competitiveness. In fact, it allows individual countries the flexibility to set prices higher than the floor price, which they may want to do so if they're concerned about the fiscal revenues from carbon pricing or they like the large domestic environmental benefits from carbon pricing.

Maybe it's Sweden where it's politically more acceptable to have a stiffer carbon price than in other countries, and that's the way we've handled undertaxation at an international level in other context.

For example, in the European Union, we don't force all countries to have the same value-added tax or the same tax on tobacco, alcohol, and energy products. We have minimum tax floors, but countries have the flexibility to set tax rates higher than the floor tax.

So we think that's an arrangement that policymakers should be discussing now as a compliment to the tax process. The complication is that you would need to account for well, maybe some countries don't fully price all emissions, maybe they have some exemptions or maybe at the same time they're adjusting pre-existing fuel taxes, so that can enhance or offset the effects on emissions.

We think it's all analytically quite practical to come up with procedures for taking those

other factors into account.

On this issue of pricing versus regulation, yes, if the only problem you're trying to address is a pure emissions externality, then it's always more cost effective to use a pricing instrument rather than combining a pricing instrument with a set of regulations.

But for political reasons, maybe the appropriate -- the needed pricing is perhaps politically too difficult in a political country. That's one reason why you may need to have a mix of strategies.

Then as we've discussed the other reason is that there's a range of other market failures that you're simultaneously trying to address, particularly technology related market failures.

So you want some complimentary measures to be promoting more R&D into emissions saving technologies and perhaps promoting their deployment as well.

MR. DERVIS: Joe.

PROFESSOR STIGLITZ: First I want to address a couple questions about how you deal with the employed and the fact that there are always going to be shocks to our economy and that -- for some people from one sector to another.

What is very clear is that market economies don't handle that very well and for good reason. The sectors that have been adversely shocked, they lose their fiscal capital, they lose their human capital, and that's why a fishing government policy has some kind of program, not only to provide, you might say, social protection for at least the younger people to help them move into more productive uses.

So that kind of industrial policy is really I think an important part, not just in this area, but in every area. This happens to be a very important area where it's going to be very big, but I think we'll have to address that.

The general principal in taxation that it's always better to tax bad things than good things is really illustrated by the advantage of a carbon tax.

But the other side, when you design optimal taxation, you have to design optimal taxation with an awareness of all the market failures and all the distributive consequences, and that really fits into exactly what you're saying.

It could turn out to be that the price that you might have to charge to elicit the responses that you need could be very high. There are all kinds of behavioral impediments, behavioral economics that show people don't act necessarily rationally.

If you had very large changes and very large taxes, it could be the case to offset that you would need to have large redistributions. The question is would those be acceptable and would you be able to do that effectively. So it may be that the optimal policy mix includes an awareness of these and mixes -- combining them together.

The same thing we've known since the work of say Marty Wiseman in a second-best world, there are uncertainties associated with -- there's instrument uncertainty when we don't know the consequences, it's not always clear whether price or quantity regulation is better.

That goes back to the general framework that both Nick and I emphasized, it's dynamic public economics, you learn. The question is what is the best way to learn, and I think that's something that we can -- should all agree on.

So finally let me mention -- answer the question about comparative advantage. There is going to be some distortion. If you don't have the same price, there's going to be some distortion, but there are all kinds of these distortions.

The real question is both the magnitude and how we learn to live with it. I think Adele made a very forceful argument is for most of these, it won't be the dominant effect, but it is argument for why if United States just walked off, that would be a problem. Adele talked about it from the point of view of the United States.

Now, you flip that reasoning abroad, everybody abroad seeing the United States not participating, they would have responses. Among their responses would be to say, we can't allow this as part of the international community, what are the instruments that we have, and they would think about alternative instruments.

Among the instruments would be a broader adjustment tax. It would be hard to believe that that would not be one that people would not think about.

So it seems to me that that is part of the background as people are thinking about responding, and hopefully it keeps us working together. The main motive should be that it's in all of our

interest, it's a cooperative spirit.

It's unfortunate that one country has announced that it's not thinking about things cooperatively, but in a noncooperative spirit. Hopefully the others will put that aside and continue to act in what you might call a cooperative gain in that spirit, but the alternative framework is a possibility.

MR. DERVIS: Nick, some last word.

LORD STERN: Yes. I want to follow up with just a few of the questions. Good industrial policy, and we now in the UK have a department for business energy and industrial strategy.

Good industrial policy promotes and facilitates change. It's not there to prevent change. I think that's an important guiding principal wherever you look, including in coal.

I haven't checked the numbers, but I think the U.S. has lost about a half-million jobs in retail this century and probably more than are at stake in the coal -- many more at stake in the coal sector.

How do you manage that? It's a similar kind of question. When you talk about coal or shipbuilding in the UK, was an earlier example, those things have a special feature of place that are concentrated in one place.

Sometimes that facilitates policy. I thought Adele gave a very convincing set of policies that could handle what happens or do your best to manage what happens when your losses occur in one place, but it's about managing and facilitating technical change in a competitive world. That's the way to keep up employment and to keep up productivity.

On prices and regulation, it's not true that prices role is efficient in a world more efficient than regulation than a world with uncertainty learning and economies of scale.

We switched as a world from leaded to unleaded petro largely through regulation. We could have had a price for lead. This is what it costs -- going to cost you to pour lead into children's brains, that would have been one way of doing it, but we felt politically it was better to do it that way, but also economically the clarity of clear deadlines allows people to invest with competence and technical change and doing things differently.

So the incandescent lightbulb, which has largely been banned in Europe and the arrival of the LED lighting, which is transforming lighting, cutting emissions and energy use by a factor of around

ten came -- was really accelerated by that action, good economics. It's not violating some rule. It's about clarity, economies of scale, and so on. So it depends where you look.

I think the instinct to start with prices is basically a good one, but we shouldn't be blanket in saying that. Education, persuasion, we're not very good at it. We lost the Brexit. You know what side I was on.

We lost the Brexit story, because we didn't articulate -- it was a collection of reasons. I don't want to oversimplify. But one feature of that was poor communication. The Brexit argument ran, are you happy with your lot, no; do you like foreigners, immigrants, taking your jobs, no; and do you like other countries telling you what to do, no; so vote leave.

It's 10 seconds, right, and the only thing we had that was remotely close to that was you're much more likely to be treated by an immigrant than be behind an immigrant in the cue.

Now, basically we didn't do very well. The challenge is to find ways of communicating that are snappy and right. Now, my father would never have dreamt that his son would praise a Pope, but this -- the Pope is very good at that. If we destroy creation, creation will destroy us. God always forgives, people sometimes forgive, nature never forgives. Now, you can logic chop about what's this creation, but basically those arguments are right.

So what you have to do is to get much better at that kind of communication, probably doing more on YouTube, or whatever, that's not my skill, but we have to think about that and we've not done very well.

Business, faith, and security services are a big part of that story. Business has been doing increasingly good job in explaining why it matters, explaining what they can do, showing themselves to be responsible, and doing well by that.

Faith leaders, I've already mentioned the Pope, and the security service and the military are pretty good on this too. I couldn't -- I don't know how to communicate with this current White House, but I wouldn't mind betting that business, faith, and security might be a way of doing it, brackets plus family. We have to think hard. It's a very important question.

Finally, I want to conclude, this really is the growth story. Infrastructure, if done well, you can always mess things up, but infrastructure investment now, sustainable infrastructure, Mr. President,

surely you'd want the infrastructure to be smart, clean, modern, and robust. It beats dumb, dirty, old-fashioned, and fragile, surely, so that infrastructure story is a big one, and it's shorter to medium term.

In a medium term, we set off a (inaudible) story of discovery and innovation, which we are a real driver in technical change. We've seen that in waves of technological change in history.

Finally, there isn't a high carbon long growth story because it creates an environment so hostile it undermines itself. So this is the growth story, if we do it well, if we think it through, if we are smart about policies, infrastructure, and so on.

And that I think was in a large measure what drove the Paris Agreement, and we have to show now that we really can deliver on that story.

MR. DERVIS: Thank you, Nick. Well, let's give a round of applause to our panelists.

(Applause)

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