Conference Transcript
The macroeconomic implications of climate action

Introduction and conference outline
Monday June 5, 2023, 9:00 AM EDT
and
Session 1: The macroeconomics of climate change mitigation: The state of play and shortcomings
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Adam Posen: -- for International Economics Conference on the Macroeconomic Implications of Climate change. I'm Adam Posen, the institute's president, and it's my privilege to have co-organized this conference with my friend and colleague, Jean Pisani-Ferry, a little bit more about Jean and his leadership in a moment. The title of this conference is meant to be construed broadly. Some of what we're talking about is macroeconomics as normally thought of. But what we're really talking about is how we get from here to there.

After much too long a struggle, the governments of the world have recognized and acknowledged the need for addressing climate change, the commitment to, ambitious but perhaps insufficiently ambitious carbon targets, and in most cases, the need for large scale public investment and subsidization and other programs to keep us on track for those targets. For a long time, economists working in this field, including our longtime colleague William Klein here at the Peterson Institute, obviously Bill Nordhaus, others, were working at the big picture level possible of what would proper carbon pricing look like. What would the costs or benefits be of getting to various temperature level limits?

And of course, there are many, many economists, including many working in Washington and Washington organizations and international organizations who have tried to tackle this. But Jean and I believe, and the response to this conference, I think, makes clear that there is still a lot of work to be done that needs to be done urgently, how to get from here to there. In particular, and this is the sense in which we mean macroeconomic, that there are transitions that are going to have to be made, structurally in the economy between sectors, reallocation on a large scale of capital and labor, mobilization of large amounts of public and private financing,

financing through the fiscal system, and then of course, the implications of this for productivity, inflation, and growth.

And it would be nice to say assume a good carbon price and all falls into place. And that clearly has a component. It would be nice to say assume the private sector is properly incentivized to get all this done. It would even be nice to say and even more unreasonable to say that if we put enough leaning on asset managers and banks, everything will be reallocated sufficiently well. We do not believe any of those statements can be relied upon. They are all in part true and in part insufficient.

And so, today's conference and tomorrow, working with a distinguished global group of economists, we are going to be thinking about these issues of what if we do take measures for accelerating change to limit and adapt to climate problems, what does this mean for the macro economy? What is the feedback on government policy? And particularly as the Institute for International Economics, talking in the end about if different countries have different structures and pursue different policies at different rates, how do we achieve the ultimate goal? Does free riding or perceptions of free riding, different forms of funding, what kinds of conflicts do these create? What possibilities for cooperation are there internationally? What needs to be done? This is a very ambitious agenda, and we're very proud to have it here at the Peterson Institute.

I particularly want to point out that we just released a paper by Kimberly Clausing and Catherine Wolfram, both of whom are at the conference today and tomorrow, on this issue of differential speed and approach, particularly the European pricing approach and the US subsidies approach. This does not perhaps settle the issue, but I think it's an incredibly important step forward, and this is the spirit in which all of the work of the conference needs to be done, not that it's about international coordination, but it's about practical economic analysis of how we get there, from here to there.

And with that, I want to thank and acknowledge in particular Jean Pisani-Ferry. Jean was the vision for this conference and the intellectual leader in assembling this group. I've been privileged to work with him as I have in the past, but particularly on this project where he showed the vision and the drive. Jean is, I'm proud to say, a nonresident senior fellow at the Peterson Institute. He also is a professor of economics at Sciences Po in Paris and a senior fellow at Bruegel, which of course, he was the founding director from 2005 to 2013.

He sits on the supervisory board of the French Caisse des Dépôts and serves as a non-executive to chair of I4CE, the French Institute for Climate Economics. In recent years, he served in a number of distinguished leadership and advisory roles for the French government working for and

with President Macron. He also had previously been an adviser to the -- a member of the French PM's Council of Economic, oh, excuse me, Executive President of the French PM's Council of Economic Analysis, and as an advisor to the French Minister of Finance.

He just recently published an important new report on the French economy. And we are looking forward to taking its lessons to the global economy. But today, I'm very proud that John is here as the leader of today's effort, today's essential effort. And I'd like to ask him to describe where he feels the conference is going today. Thank you, Jean.

Jean Pisani-Ferry: Thank you. Thank you, Adam. Thank you for your nice words. The purpose of this conference, let me try to say differently what you already outlined, the purpose of this conference is really to bridge the gap between macroeconomics and climate economics. And for a long time, these were two separate fields. So, and they developed, they developed separately. So, for the macro economists, climate was an important issue, but always beyond the horizon, always for the long term.

So, they thought of it as an intertemporal concern, and they regarded it as important, even vital, but without much influence on their, on their day to day decisions as regards the budget, as regards the growth outlook, as regards interest rates, et cetera. And that was the view of the macro economy. The climate economists had quite a different view. They developed their own analytical framework, which sort of grew out of public finance, grew out of a question of intertemporal optimization, and they weren't very interested in becoming part of the macroeconomic policy discussion.

And so there was little room for macro policy in their framework, and they had little interest for it. And my sense is that, our sense is that all that has begun to change, first with the Paris Agreement in 2015, but more importantly, more pressingly, with the European Green Deal launched in 2019 and then finally became or has almost completely become part of the European law. So, there is a European plan and this is having significant macroeconomic implications. And then the US Inflation Reduction Act, which is also something that is part of the US policy framework, and that in '22, so less than a year ago started changing the landscape.

And the question now is with those two major changes, do we have a proper analytical framework? Do we have a toolbox, a common toolbox? And do we have a well-defined, adequate methodology for making the bridge between climate economics and macroeconomics? And my impression is that we don't. We don't because those are still separate fields. And the conference is conceived as a way to sort of start a conversation between people who start from different angles but may wish to convert. They all

recognize now that the importance of the topic, but they haven't converged on a methodology and a toolbox.

So just to give you a few examples, we're still very uncertain about the impact on the green transition on total factor productivity and potential output. The papers presented at this conference start from different premises and come up with quite different results. So that's a conversation we need to have and we need to sort out to the extent possible. The reason why the question arises is that there's going to be a lot of investment that everybody agrees on that.

But the question is what sort of investment is there going to be? Is it an investment that is going to increase the potential output, increase efficiency in a traditional way, or is it an investment that's going to save on fossil fuels, and therefore that's going to be distracted from the traditional focus of investment? And when I'm speaking here of investment, I'm speaking both of research investment and productivity investment. So that's the first question.

Second question, the impact of the transition on labor and capital market. Rough calculations, and again, they will be presented at this conference in the paper by Robert Lawrence suggests that those numbers are small; they're too small for real concern. And there are good reasons to, to consider that in principle they should be small. Now, the record of reallocating factors, labor and capital, especially labor, in a situation where there was, again, I mean, globalization was bringing a gain to the economy at large.

And the record of, of relocating labor has been so poor that I think we should look twice at the ability to relocate labor and capital. So that's something also we may wish to discuss. Third item, the fiscal impact. The fiscal impact, it's interesting because, I mean, we all come from the view that carbon pricing would deliver the double dividend. So, on the one hand, it would deliver more resources, fiscal resources, and on the other hand, it would deliver the possibility of using these resources to limit the pollution.

So, the question is that the more we go into concrete development, the less likely it seems that this transformation is going to deliver the type of results I was just alluding to. It seems increasingly likely that there will be a fiscal cost, and the question is how large a fiscal cost will be. And that's something we want to discuss, obviously. Let me speed up a bit because I could go on for a very long time.

But inflation in principle, it's not a first order question. We're speaking of changes in relative prices. We have this tradition of distinguishing relative prices from the general price level, but we also have this view, this prevailing view that the transition to a carbon free economy is going to be

very positive in the long run in terms of the availability of resources at a low price. But it's going to be a very bumpy road towards this long run because the lack of adequate investment, all that is going to both for internal reasons and international reasons to add to inflationary pressures.

And this we are going to return to with the presentation by Pierre Wunsch, the governor of the National Bank of Belgium. And finally, last but not least, there is a question of competitiveness in international trade. So, for a long time, the assumption was the day the US joined the Paris Agreement, problem solved. The US joined the Paris Agreement. It's a very positive development. But it has created also a host of new problems. And those problems are at the core of the current discussion. And we are going to have papers and presentations on that.

Now, those are the issues we are going to discuss over the next two days. In part, this discussion will have a very sort of advanced economy flavor, but not exclusively. The papers by the fund, papers by the bank, they include economies that are developing or at different stages of development. And we also have a last panel with the participation, especially of Suman Bery, the Vice Chairman of NITI Aayog, and Mauricio Cardenas, the former Minister of Colombia, I think, and now with the Colombia University. And this panel chaired by Adam will be discussing the wider implication for the world. So, a combination again of very focused, but also broader issues that we want to discuss. Thank you.

Adam Posen: So, in best Peterson Institute fashion, we're going to get right into substance. If I could ask the aforementioned Suman Bery to come up to chair the first panel and the presenters and discussants to have seats. We will begin.

Suman Bery: Thank you, Jean. Thank you, Adam. I'm being given double duty or double privilege both to moderate this first panel, but also to be, as Adam just, or Jean just mentioned, to be a speaker at the final session. I think I'll leave my extended remarks of why I'm here and what a pleasure it is to be here for that second session in the interest of time. And let me therefore just indicate, welcome the participants in this first panel and give an indication of what my role is going to be. So, we have two papers and two discussions, and I'm told that the Peterson tradition is for all introductions to be done up front so that we can then move on.

So, the first paper will be presented by Antonio Spilimbergo of the International Monetary Fund. He studied economics at Bocconi in Milan, received his PhD from MIT, worked at the Inter-American Development Bank. Since 1997, he has worked in the European Fiscal Research and Western Hemisphere departments of the fund. His areas of interest are trade, development, labor economics, political economy, and macroeconomics. He is widely published in the leading academic journal, has edited two

books on Europe and Brazil, and is the author of the book “Si-Vax”, and has also, on the operational side, been Mission Chief for Slovenia, Italy, Russia, Turkey, and Brazil. He's a research fellow at the CPR.

His presentation of 20 minutes would be followed by John Hassler, Professor of Economics at the Institute for International Economic Studies at Stockholm University. John's research has covered areas of dynamic public finance, social mobility, growth, and climate change. His work has been published in the ER, Econometrica, JPE and other international journals and is a member of the Prize Committee for the Prize in Economic Sciences in memory of Alfred Nobel, where he has served since December 2009, other than one year.

He was chairman of the Swedish Fiscal Policy Council and is a member of the Royal Swedish Academy of Sciences and the Royal Swedish Academy of Engineering Sciences. He has worked as adviser to the Swedish Ministry of Finance during the financial crisis and is a member of the Finance Minister's Economic Council. He serves as a scientific advisor to several government agencies and has been a member of the Bellagio group and got his PhD from MIT in 1994. And the two discussants are Alain de Serres, Head of Structural Policies Surveillance Division at the OECD.

He's a Canadian national, and in his capacity as Head of the Structural Policy Surveillance Division, he supervised the publication of the indispensable annual Growing, Going for Growth Report, which provides the main policy priorities and recommendations for boosting growth in all OECD countries. He has recently worked on the policy determinants of investment in knowledge-based capital, and prior to that, he has contributed to the development of a framework for the analysis of green growth policies. Part, part of this work has been published in journals such as Economic Policy, European Economic Review, and the Journal of Economic Geography.

And last, and very much not least, James Stock, Vice Provost for Climate and Sustainability, and the Harold Hitchings Burbank Professor of Political Economy at Harvard. Uh, he is also a member of the faculty at the Harvard Kennedy School, and his current research includes energy and environmental economics with a focus on fuels and US climate change policy and is well known to many students as the coauthor with Mark Watson, with whom he's published extensively, of a leading undergraduate econometrics textbook.

And in 2013, ’14, he served as a member of President Obama's Council of Economic Advisors, where his portfolio included macroeconomics and energy and environmental policy. He was chair of the Harvard Economics Department from 2009 and holds both a MS in statistics and a PhD in

economics from Berkeley. So, I do feel extremely honored to have been selected to moderate this first panel. Let me just make one of the points about myself in this role, which is to say that after a long period in the think tank world, I was selected by Prime Minister Modi to head NITI Aayog.

And in that sense, I'm here as a government official, but I'm here largely because of the importance of this discussion for issues facing NITI Aayog, which is, if you like, the structural, is the indicative planning, the France strategy, if you like, of India. And so, while I will make the views of my government known, particularly in the last session, I'm really here and honored to be considered a scholar. Now my role as chair is iron fist velvet glove, as I was told by Adam. 20 minutes for each presenter, then 12 minutes for each discussant. And I'll try and be rigid on that, so there's time for discussion amongst the panel, to questions that I might have for them and then questions from the floor and only, I understand, for those in the room. There won't be questions from the livestream, even though the event is being live streamed. So, at 9:25 by my watch. Antonio, you're on.

Antonio Spilimbergo: Thank you. Should I?

Suman Bery: As you like.

Antonio Spilimbergo: I sent a presentation.

Suman Bery: Yes.

Antonio Spilimbergo: Thank you. It's a pleasure and an honor to be here. Thank you very much for this invitation. This is a paper written by Pierre-Olivier Gourinchas, who is sitting there, and Gregor Verhoef, who couldn't come, and myself. This is a survey piece. It's a selective survey piece. And among the huge literature about macroeconomics and climate, we selected three topics, and we selected three topics because, and the scenario has changed. And I want to justify why we chose these topics. Let me step back. Where we were in -- no. How do I turn?

Suman Bery: Here.

Adam Posen: Can we get the slides back, please? Thank you.

Antonio Spilimbergo: Thank you very much. Well, let's step back to 2015. 2015 at the time of the Paris Agreement are the framework under which all climate policies were conducted. As you know, every country volunteered some commitments to reduce emissions compared to the business as usual. And there were several challenges with this approach. And every country was left to deal internally how they could reach that that objective.

Speaker 1: We are on the next slide.

Antonio Spilimbergo: Okay. Yes. And the challenges were basically, first, the climate action to which country committed were insufficient, were considered insufficient. And there was the idea that a global effort was required. There was a debate about the relative contribution by advanced countries and emerging markets about how much each set of countries should contribute. And emerging markets were particularly concerned about the political and economic costs of implementing carbon pricing in particular, but carbon policy in general. This was the debate until six years ago.

The landscape has changed dramatically since then. And I feel, we feel that the profession has not caught up with the new challenges. What has changed? First, well, under this scenario, many simulated some costs of transition. I think that there was a variety of, of estimation. But we, for instance, the fund estimated that about 0.5, 0.4% of GDP were sufficient to reach those objectives. This was predicated under the idea that each country went to the first best and applied well designed policies, and there was international cooperation.

Unfortunately, we don't live in a world of first best, and well-designed policies is not feasible sometimes. So what are the new challenges that were not foreseen at the time, including this one. Well, after 2015, there was a wave of populism. President Trump was elected in 2016. In emerging markets, you have also Naro. In France, you have [inaudible 0:28:20]. So, this was unexpected somehow in 2015. So, the domestic challenges turn out to be much more important than expected [inaudible 0:28:31].

Second, COVID-19, it was completely unexpected. And this raised all sorts of other concerns for international cooperation. One legacy of the COVID-19 shock was that international cooperation was broken in the vaccine distribution. As you may remember, some countries were advocating for distribution of vaccines licensing, and this didn't happen. So, all the talk about technology transfer also in green technology somewhat was tainted by this.

Third, the growth forecasts were revised quite dramatically down. Fourth, there was a commercial increase in protectionism. And this is very important because all the achievements done before in green transition were done by specializing in China became the, the big factory for the world of solar panels. But of course, if you have protectionism, this is not possible. And finally, last but not least, the Russian invasion of Ukraine, which completely destroyed the international cooperation in many fields.

Suman Bery: [Inaudible 0:29:41] live stream, maybe --

Antonio Spilimbergo: Okay. So, these were big challenges, big challenges which are completely unforeseen in 2015 at the time of the Paris Agreement with which we have to deal with. Otherwise, we are not able to make progress. Against this background, I will focus on three issues. One is the issue of energy security, which was raised dramatically after February of last year, and the different approach of macroeconomic approach to macro, to climate policies that US and Europe have pursued. And this is a consequence of the rise of populism in the sense that you can think about the rise of populism like putting constraints on the available set of policies that country can have. And given that they are obliged to follow some path, this path can be conflicting, raise other issue of international cooperation.

Finally, I will touch about the international political, yes, technological progress that there is also a nice surprise there. So, I would focus on these three issues as I mentioned. There is another issue that I'm not touching, but I think it's as important. And it's about political policy uncertainty. As we came to the realization that a fiscal effort is not enough to cover the needs for transition and we need the private sector, we need to have stability in, in an investment framework. However, at the same time, there is the uncertainty about the framework has increased over time, and this poses a big challenge for the transition. So, the fiscal policy is restricted for the reason I listed before.

At the same time, there is more, more uncertainty to attract private capital. Energy security. Energy security was always there, but came immediately and all of a sudden to the fore in February 2022. This graph speaks to itself. No. Yes. This is for United States and for Europe on the right, on the center left. In blue line is how many times is a normalized 200, energy security is mentioned in a major title of newspaper. And the red line, mentioned green transition. As you can see, especially for Europe, as Russia invaded Crimea, not Crimea, Ukraine, there was a huge jump of mentions of energy security. Of course, this is a nice real time indication, but this is very important because politicians respond to this.

So, all of a sudden, within 24 hours, the entire debate on energy transition was trumped, was overlapping, was clashing with the issue of energy security. As I mentioned before, the big issue that we had to deal before is about certainly our policies. And now in 24 hours, the priorities start changing. And we were hoping to have a framework for years. And in 24 hours, you have a dramatic change. You see that, sure enough, over time, the blue line is going down, but still for a year was dramatically higher than the other line. What is the problem with energy security? And the choice is made to deal with emergency in the short term have long term implications.

Here I'm just talking in general, but in the paper, we discuss more at length. The issue is how you deal with short term in shocks, have big term implications. And the reason is that energy requires long term investment. And so, if you incentivize, if politicians get very afraid about short term concerns immediately and they change the political policy framework, the consequences are there forever. And a good example is France in the 70s, that already France was on the path of nuclear, but with the nuclear shock, with the energy shock, there was the political decision to become independent. Possibly it was a good choice, but it was done under the duress of the shock.

So now somewhat, we have a similar turning point. The similar turning point is more complicated because it involves also emerging market. There is a big investment in Siberia building the new pipeline going to China, power of Siberia. And we have to ask whether for the Chinese authorities it is more convenient to rely on cheap energy, brown energy from Russia or to continue the path that we are taking. So, these are very important topics that we are not well equipped to deal with. And we are at a fund, we have several work stream on this.

Okay. I'm not following. Yes. So, this, the green, the energy transition and the, how to say, energy security interact in a very interesting way, and it is still out the jury to understand what is a net effect. Let me go to -- Yes. One issue, however, that I think is very important is the green transition. Also, on one side, it means more domestic production of energy. But at the same time, the green technology require on some minerals which are heavily concentrated in some countries. So, the geography will change, the geopolitics will change away from some oil and energy producers towards some other actors, Chile, Brazil, Australia, Argentina, Indonesia have some key materials, and this is very important. So, it's not that producing domestically energy will solve the issue of energy security. It will change the reliance to another set of countries. And this involves all sorts of questions of geopolitics.

So, in the long run, and here we elaborate more in the paper, what is crucial is how domestic policymakers react to the shock and the indication they give. And at the same time, it's very important to, to remind that green energy doesn't mean necessarily a safer energy. So even, overall, yes, but with some important caveats. The other caveat, which is very important in Europe, for instance, is the issue of intermittency. We know that a lot of green energy is a challenge of intermittence, and for that, you need international links and grid, and that increases the dependency from outside.

We know that Germany, for instance, imports a lot of energy from Norway during some periods. Different approaches to second topic -- different approaches to green transition. Here, as I said, the, the first best would be a

green, how to say, carbon taxation. However, given the emerging domestic political constraints, countries had to choose different approaches. So, they solve an issue domestically, but another issue arises which is international coordination. Here we have done quite an amount of work because the issue is to try to simulate with models what it means for not only for domestic macro outcome, but especially for the interactions.

And the other problem is a Trojan horse, is that in order to pass the green policies, you need to have an unholy alliance with protectionism somehow. You need to give some currents. Now we are in the world of second best. So many people, several including Dani Rodrik, who was at the conference yesterday, said, well, this is a price worth paying. At the same time, it's a Pandora's box. It's not a Trojan horse. It's more a Pandora's box.

And once you open the Pandora's box, the interaction, and many Pandora's boxes actually because it's in Europe, so it's much more complicated. And I think we have to dedicate more energy to understand the interaction between, among these. At the fund, we are doing a lot of work on this. Here I go quick because I think that in this audience, everybody knows. I was discussing -- No. Mm hmm. Apologies.

Okay, here, we did some simulation looking at the, at the macro effect of various, of various policy adopted, and the GDP costs were not as large as. However, I think that we have to consider the possible interactions which, which become much more complicated over time. The policy of political interaction between these, these -- Okay, just a second -- technology. I want to talk a little bit about the technology because I think it's a very nice surprise that we did not anticipate in 2015. As I said, there are many bad things we did not anticipate. But there is one good thing that also we did anticipate.

And we can think about the future of green policies like a race between the bad political backlash and the good technological progress. And the race between these two will determine the final cost and the outcome of this. What do I mean? Apparently, given that I'm short of time, I show these two graphs, which I think is very important, are very important. One is about the cost of solar energy that has gone down dramatically. Not only has it gone down dramatically over time, but what is important in this picture is that the torch of the technological progress has gone from country to country.

So first, it was mostly the US. Second, it went to Japan, again to the US, and after, there was the rooftop program for the, for Germany, and after, it went to China. This shows that the adoption, the developing adoption of technology requires a lot of international cooperation to fully exploit comparative advantage and the economy to scale. What I'm afraid now is

that if there is a breakdown of international competition, these dances of technology will, will be interrupted.

And this is a nice picture that I like. We always seriously underestimated the capacity in solar -- systematically in solar capacity, which means because the cost, we underestimated the cost, and we underestimated the ability of adopting this solar panel. And this is a nice surprise. And as you know, last year, last week, there was a, I think the Financial Times announced that for the first time in 2022, the investment in solar energy is higher than the investment in brown energy.

So, in the paper, we have a section on the patent also there, there is a little bit a problem that in, on the patenting, that there was for a while there was a big boom in patenting green, but recently there was a slowdown. And there is a concern that the low carbon prices, there is a kind of maturity in technology maturity. And so, the technology is not going to progress as rapidly as we hoped before. And conclusions. It is a survey piece. We have to be very selective because the survey, the leaders are big.

We chose two, three topics. One is energy security. We need as a policy institution to give advice, how to deal with the shock. And second, we have also to be very aware of the political economy, domestic political economy, which really constrained the ability to collaborate. We focus on the US and Europe, but the political economy in China and India is as complicated, if not more. And this is a big issue. The green light is that the hope is that the technological progress will solve part of these issues. And I don't have -- Yes.

Suman Bery: Well, thank you very much, Antonio. Being a European, I was ready to grant one minute extra time, but you didn't need it. Could I now ask Jean to come up to the podium?

John Hassler: Thank you very much. It's a great honor to be here. And it's also going to be fun to talk to you and to listen to all the other talks. So, climate and macroeconomics. So, the starting point -- It is a little problematic this clicker. I seem to have problems, not only Antonio, me, too. So, the starting point for the whole discussion of climate and macroeconomics is, of course, the natural science fact that greenhouse gases works like a blanket around Earth. And that's good because otherwise we couldn't survive here. But with more greenhouse gases, the blanket gets thicker and that leads to warming.

And since a large share of the emitted CO2 stays for a very long time in the atmosphere, hundreds and perhaps thousands of years, we know that it is cumulative emissions of CO2 that drive the climate change. And the conclusion is obviously that, eventually, we have to stop this and become climate neutral. Economists, I think, have a strong comparative advantage

in describing how this can be achieved, which policies are effective in making the world transition to climate neutrality and which are not. And I think we have so far not used this comparative advantage sufficiently enough. And if you look at what comes out of the massive reports from IPCC, it basically has nothing of this sort, which policies work, which policies do not, and how can we achieve climate neutrality. So, we really need, I think, to step up and use our competency here.

Jean said that we don't really have the tools. I do think we have actually. I think that the models that we have, our quantitative macroeconomic models, are extremely useful for analyzing the challenges in climate change and what policies work and which don't. And of course, we cannot expect exact answers, but we cannot do that with other things that we are involved in either. And of course, also, the models need reasonable inputs, otherwise they're not going to be useful for policy advice. So, I'm going to here give you a few observations that come from natural science and from other areas that I think serve as important inputs to both modeling but also to the policy discussion. And I'm going to use those observations in a fairly standard macroeconomic neoclassical growth model to draw some conclusions on policy.

I'm going to call this tentative results. But of course, I understand that many of the details that we're going to discuss here today and tomorrow are not in the models. And they might change at least somewhat the results. But I think it's important to not only focus on the details, but also have the big picture with you in the analysis. So, I'm starting with the third observations. The other two are in the paper. So, you'll have to read the first two observations there. But the first observation that comes from natural science is that to the best of our knowledge from science, the global temperature increase is proportional to cumulative CO2 emissions without any tipping points or other non-linearities.

And this is the basis for the possibility of calculating carbon budgets, i.e., budgets that tell us how much we can emit in the future without breaching some - whatever temperature limits that we want to stay below. There is something that doesn't work as it should. So this is a graph from the latest IPCC report that demonstrates this third, this point, the observation that I just gave you that the change in the global mean temperature, which is on the y axis here, is proportional to over time cumulative CO2 emissions.

So, this graph shows this linearity, and we have so far emitted around 2500 gigatons of CO2 since we started like 150 years ago. So, to the left of that point in the graph is data, and to the right is forecasts of different emissions scenarios using different, different models. And you see this clear linearity between cumulative CO2 emissions and the global mean temperature. Another point that is important is to think about -- I think we need to do

something about this because -- Okay. I have my own clicker with me. Maybe I should use that one. We'll see what's happening. But this is not working as it should, I think. So, another point is that the amount of fossil fuel in the ground is very large, so we can't really continue until we run out of fossil fuel in ground, and we can compare it to, for example, the carbon budgets for one and a half to two degrees.

So, this is for fossil fuel in general. If we talk about more conventional sources of fossil fuel like oil in Saudi Arabia, gas that is cheap to take up and so on, then the amount of those reserves are in the same order of magnitude as the carbon budgets that we think are reasonable, one and a half and two degrees. The fifth observation here is that the frequency and the intensity of weather extremes are also proportional to temperature and emissions. I don't know how we're going to do this because -- So here, this is a graph from the IPCC that shows heavy precipitation events.

So extreme events, extreme weather events are what we are worried about, not just the average temperature. Here, we see in this graph that the global, if we plot the global surface temperature, where again, we are now at around one degree and then you have potential higher temperatures in the future. And this shows then the relative frequency compared to pre-industrial times on the left y axis and the intensity on the right, the right y axis. And you see this linearity between both the frequency and the intensity of extreme events.

And this goes also for droughts. You see a similar linearity. And you can see it for heat extremes where, for example, you can see that. So, in this, you have the ten year, the hottest day in the ten year period calculated pre-industrially and the hottest day in a 50 year period. And you see how often these are going to happen in the future under different assumptions about the global mean temperature and see this linearity here, too.

The sixth thing, which is perhaps the most important when it comes to policy, is the very large uncertainty around these things that I've talked about so far. So, for example, IPCC and the Sixth Report says that the current human influence on temperature is likely between 0.8 and 1.3 degrees, and that's a pretty large range. They also say that the cooling effect of aerosols is likely between 0 and 0.8 degrees. We are emitting particles into the air, aerosols. And this, this produces a cooling effect that might not be strong at all, but might also be as strong as 0.8 degrees.

The proportionality coefficient that I talked about before, that is also very uncertain. And, uh, and you can realize that, for example, if we emit twice as much as we have done so far in the future, that's going to add likely between 0.625 and 1.5 degrees. Likely here, as according to IPCC, should be interpreted as a two thirds probability interval. Now it comes. Now we're

going to come to the other set of observations regarding damages. So how is the economy going to be affected, our welfare is going to be affected by climate change?

And there, I would say that the one type of studies, namely so-called bottom-up studies that try to identify different mechanisms whereby climate is affecting our welfare and then quantifying those and aggregating up, those kinds of studies point to relatively modest effects of on the economy. This is an example of a very good study for the EU that discusses what's going to happen to our economy in a number of different areas, namely river flooding, coastal flooding, agriculture, droughts, windstorms, and energy, and mortality, mortality during heatwaves.

Now you see, this is the idea here is to try to quantify the effects. If the world global mean temperature increases by one and a half, two, and three degrees immediately, so instantaneously without any possibilities for adaptation, and you see that there are relatively modest effects also for the highest degree of warming here, a couple of percent of GDP where the largest share is the, the effect due to mortality, where kind of standard values of, of lost year lives are used.

The effect is somewhat larger in, in, in southern Europe, which I just blinked forward. But up in the northern parts of Europe, we have basically very little. There is another set of papers trying to estimate damages from data, trying to infer by statistical methods the effect of, for example, growth of changes in the temperature. They tend to produce highly uncertain or even nonsensical results. So, there is a famous study by Burke et al. that's used as input to many climate models that just exactly this, see how natural variation in temperature affects growth.

I took their estimates and projected what's going to happen in the European countries if we get a global mean temperature of 2.5 degrees towards the end of this century. And I think these results speak for themselves, that Sweden, for example, would be five times richer with climate change than without and Finland six times richer. And in my mind, that makes absolutely no sense. Uh.

So, the conclusions here is that we have a high degree of uncertainty around the consequences of emissions of CO2. And I don't think that it's possible to quantify these things objectively. And this means, I think, that the calculations of the social cost of carbon and optimal carbon taxes based on cost benefit analysis and best guesses is not really convincing. We can discuss what the assumptions should be about these things that we are highly uncertain about, and we're never going to agree on that. And I think that also the uncertainty here is unlikely to vanish.

My thesis many years ago was about investments under uncertainty. And often, when you are uncertain about the decision, what decision to take, there is a high value of waiting, but that really relies on that you learn, you see why by waiting. And I don't think that we are actually. These uncertainties that I'm talking about are not value, are not vanishing. And that means that there is a low value of waiting and at the same time a pretty high cost of waiting. So instead, what we should look for is robust policies, and with robust policies, I mean policies that have little room for regrets, regrets afterwards. And here, I think that models are highly useful.

So, I clicked over my statement that Pindyck and Stiglitz are wrong. But because they often argue that models, because there are many things that we are uncertain about, cannot be used for policy advice. I think that's wrong. I think that here models can be used for, for showing which policies are robust, i.e., leaving little room for regret. So, this is going to take half my time, this clicking business. I don't know how to do actually this. So, now --

Suman Bery: You have five official minutes and at least two minutes of extra time.

John Hassler: Yeah. It's going to be difficult here. In the paper, we present a simple, fairly simple, almost analytical global neoclassical growth models with eight regions, and we augment that with a simple five equation model of the carbon circulation, carbon cycle and the climate. And we know from recent work that this very simple climate carbon model very well replicates the most advanced supercomputer Earth system models. We have energy coming from oil, coal, fracking, and green. And I think that this model is useful for deriving quantitative implications of different assumptions and scenarios. So let me give you some of these tentative results.

The first one is that a global or regional carbon tax is a potent policy tool. So, it has to be, and this, this graph shows this, if I get it to, to be shown. So, this is when we in the world introduce a fairly modest price on emissions. It's around $0.05 per liter of gasoline. But of course, it applies to, to, to all fossil fuels. And you see that that makes a lot of difference if it's introduced, to $0.05 per liter, that's what they said, it's $0.20 per, per gallon of gasoline. It's a fairly modest tax. And also, that little tax has a large bite. The second tentative result is that the smooth transition to climate neutrality at 2050 can be accomplished at a fairly small cost and with acceptable carbon tax expenditures.

So here in the graph, if I get it, we run through the model and experiment where we force down fossil fuel CO2 emissions to 10% of what they are today in 2050, and then we let them stay at that level with in principle implementing something like a global emission trading system. So, forcing down emissions to 10% of what they are today until 2050. And we compare

the effect of, of that on, on emissions and in particular here GDP. And you see that GDP falls a little bit during this transition, but after that, it's just a positive effect. And the cost, thus, of doing this is very small.

The second graph here, the under graph, the lower graph is instead showing how much revenue is generated, and it maximizes at around 1.5% of GDP. Not trivial, but not, neither very large. So, the third tentative model result is on, speaks on the robustness of such a policy. We argue that it offers a cheap insurance against high sensitivity of climate change to emissions and damages to climate change. So, this graph here shows this. What we did is that we took the model and said, what is the reasonable policy if we assume that climate sensitivity is high and that it's difficult to adapt to climate change? So put that policy in place, and then compare what happens if this turns out to be wrong so that climate sensitivity is low and it's easy to adapt.

That's one type of policy mistake where the tax is too high. So that's the red graph here where we have said we realize over time that we were too ambitious in climate policy. The other thing is the opposite, hoping for the best, but we think that climate, we argue, suppose that climate sensitivity is low, and it is easy to adapt, introduce a policy that is right then, and then look at the consequences of the opposite thing being correct, namely that climate sensitivity is high and it's difficult to adapt. And you see that that hope for the best policy, too little, too low of taxes is much more dangerous than the other one. And this implies then that the ambitious climate policy is robust. A fourth result is that all regions of the world must participate, compensating in some parts of the world for some large regions not being part is extremely costly or even outright impossible.

So, in this graph we show the consequences of, of assuming that India and Africa are not participating, and the rest of the world, including China, makes up by being tougher, and then they have to have five times as high CO2 tax in order to compensate for that. If China is net part, net part, it's actually not even possible to, for the rest of the world to compensate for that. So, if they do a little, at least a tenth of what the others do, then under a unanimous policy, then it's possible to kind of to compensate for that. But the rest of the world must have 20 times higher taxes. And that's probably not possible.

The final result that I want to speak to is that we argue with the basis of the results from our model that subsidies to green energy are not likely to outcompete fossil fuel. Yes. And this graph shows that. So, what we did in the model was that we assumed a faster growth in green energy technology, implying that green energy falls in price over time. But there is no other policy curbing the use of fossil fuel. And here, we show the consequences of that for temperature, and it turns out that it doesn't work at all. So at least

according to our model, green subsidies are not going to lead to fossil fuels being outcompeted.

So, I think I don't have much more time here. But let me anyway say that I, of course, realize that in our model, we basically just have one market failure, the climate externality. And in reality, there has to be many frictions that we model. And that, of course, requires lots of policy interventions. I think it's useful to think of policy as being active in three different areas with different aims where the first -- And these, all these policy groups are necessary. So, the first is policies aiming directly to curb emissions that can be done with cap and trade taxes and bans.

And the second area is to overcome other types of frictions, implying that the transition becomes smooth. We, it's necessary that the transition is economically, socially, and politically acceptable. Otherwise, the area, policy area one measures are not going to be accepted and then it's not going to work. And so these policies in policy area two are useful also for other transitions like the digital transition, digital transition and so on. But here, they are necessary because otherwise the area one policies are not going to be there. And the main difference between this transition and other transitions is not that this transition, the climate transition, is much larger. It is that it requires area one policies. The analog society is going to phase out itself. That's not the case with the fossil society. The third area is, of course, introducing making sure that the rest of the world participates.

Suman Bery: I'm going to have to --

John Hassler: Yeah. So, I know that I'm out of time here. So this, I'm not going to have time to speak about this, but I think it's important to realize here that EU now is doing what's required under policy area one. So, we are introducing carbon cap and trade systems where we are going to phase out CO2 emissions. These, these cap and trade systems are covering approximately 99% of CO2 emissions, and we know exactly how much emissions they are going to generate. And those emissions that are going to be the maximum that is allowed under the cap and trade is in line with the Paris Agreement.

If the rest of the world does the same thing, we are going to stay somewhere between one and a half and two degrees. So, this is very important. And this takes me to the final conclusion slide. And here, I'm going to end with the two last points here that I think that the EU is now doing what's required under policy area one. We are actually going to phase out CO2 emissions until the middle of the 2040s. We need to do a lot of other things, in particular under area two and three, we do the necessary thing on the policy area one.

I think that the American IRA package lacks the required tools under policy area one. It's a lot of things that makes the transition smooth and facilitates a new green economy, but I think it's also required that you put limits on emissions, and that's not done so far under the IRA package. However, this order of doing things might be the right thing in the US. It might pave the way for the policies under policy area one that are required. So, I'll stop there.

Suman Bery: Well, thank you very much. So let me immediately then, in the interest of time, now, ask Alain to make his presentation. I should mention that it was pointed out to me that the time promised the discussants was 15 minutes. So that's what I'll allow.

Alain de Serres: Thank you. Thank you very much. And I have a brand new clicker, so we'll see if we can't -- I may be able to use the full 15 minutes. So, thanks. I want to thank Adam and Jean for the invitation to participate and discuss the two papers. Thanks also, of course, to John and Antonio for great presentations. I really enjoyed reading both papers, and I think they did a great job in setting the scenes for this conference. And I pretty much agree with their focus and broad conclusions. Now, I need to switch it on first.

To help framing the discussion, I thought it might be useful to cast the challenges to climate policies in terms of capacity constraints and potential headwinds. See the constraints on the left column and the headwinds on the right. You can think of the capacity constraints being related to the availability of different inputs that, that could limit the speed of the transition. And of course, here they become particularly relevant in a context where the low carbon transition needs to be vastly accelerated and compressed over a short time horizon, going back to the point Jean was making in his introductory remarks.

Now, I might say that in typical CGE models, climate models, certainly in the case of our model, in terms of capacity constraints, I guess the first three items on top are reasonably well covered, but the bottom three are much less. And in particular when it comes to land, land here is not so much in terms of availability, but more in terms of access to land. And this can cover anything from permitting, issues of pushback by local population whenever there's a new development project and so on. But also, I think the being mindful that in trying to address the climate problem, we're not making the problem of biodiversity even worse.

So, there's all these issues to take into account, which probably limits some of the -- puts extra constraints that we're not necessarily taking into account. Also, I list also a number of factors that could potentially derail the transition if they are not sufficiently anticipated and well managed, and a lot of these have already been mentioned. But in doing so, in anticipating

them, it then constrained policy choices, gets us away from first best, and so on and so forth.

Now both papers discuss a number of these constraints, constraints and headwinds. In fact, Antonio's paper casts a success of the green transition in terms of a race between rapid technological progress versus negative political backlash. And also, in the paper by Antonio, the section on energy security provides a good reminder that for many countries, reducing dependency on imports of fossil fuels comes at the cost of new form of dependency, this time on imports of critical material. As you know, the production of which is even more concentrated than in countries we're trying to get away for other reasons, therefore creating new security risks.

Now, if I may, in the paper, I think that the conclusions, they have the three conclusions, I think they are the right ones. But there should be a fourth one on, on the need to accelerate the development of, of recycling of the circular economy. I think this is a bit downplayed in the paper at the moment. It's mentioned, but I think it should be given far more prominence and another source of potential useful investment. In the case of Jean's paper, the issue of uncertainty, as he mentioned, is central and used as the main argument to support the view that when it comes to climate policy objectives, we're long past the point of cost benefit analysis.

I think that the results you just provided on the link between temperature and GDP across countries extrapolated from reduced forms highlights well the difficulties of modeling these complex mechanisms. Now that, to me that, of course, doesn't mean that we should do away with trying to connect emissions to temperatures to economic outcomes, like you do in the first part of the paper with a simple model. Quantifying these insights from science remains, of course, absolutely fundamental, if only to assess the need for adaptation and where to adapt, where not to adapt. Also, the insights from science are important to assess the potential implications of tipping points for the desirable path to net zero. Now on this, I was a bit surprised to see how dismissive you seem to be about tipping points on the basis of the report of IPCC.

But I gather the tipping points in your paper are put in terms of relationship from emissions to temperature to climate change. I understood the risk of at least some tipping points running the other way around, from rising temperature to emissions to uncontrolled emissions, creating further risk of accelerated rise in temperature and that in things that might be some non-linearities there that might be worth mentioning. And of course, as an impact on how quickly we would want to reduce emissions if we want to avoid. So, the path, the path to non-zero matters, not only getting there by 2050.

So, your paper now then moves on to the how question, how best to achieve the needed transition link to, to your, to our carbon budget, and you quite rightly motivate the how question also by referring to the risk of political backlash if we don't seek maximum efficiency because of cost reasons. Now on this, I must say that it is the transition cost, so those over a relatively short horizon that I would think would matter most for the risk of backlash. And then, but your paper focuses mainly on the long term, long run impact of mitigation, ignoring issues related to path dependence, potential risk of, of technological lock in, another source of friction.

But of course, this is a limitation that is well acknowledged in the paper, and you do recognize this from the beginning. But even as a long run benchmark, what I could see as the implicit elasticity of emissions to carbon pricing in your model seems to be quite, quite high. If I understood correctly, you got quite some mileage out of a carbon price of about €20 per tonne. Just to give a comparison, very recently, we provided estimates of elasticities using a comprehensive database on effective carbon rates.

This is a database we've developed at the OECD, which covers all forms of carbon pricing, including carbon taxes and permit systems, but also indirect pricing from fuel excise tax, which in many cases, account for the bulk of effective carbon rates. And we do this for over 70 countries. And using these data to get estimates of elasticities across countries, sectors and even types of fuels, we find that on average an increase of €10 in carbon price reduce emissions by somewhat less than 4%.

So, to give an idea, if we move to a uniform tax of €60 per tonne, this would reduce emissions by around 15% globally. So well, short of what is needed for net zero by 2050. So, a far higher tax rate would be needed to achieve this, to achieve net zero, or we need a combination of policies that raise, at the same time raise the responsiveness of emissions to carbon prices.

And this is illustrated on this chart, which shows that with the estimated elasticity, the carbon price that we would need to achieve net zero would have to increase by €50 per tonne per year to reach something like close to €1,000, which is well beyond what I think is reasonable. And this is the pink line that you see, the one most on the left. On the other hand, if we have complementary policies, measures to raise the elasticities over time to become, say, just five times larger, five times larger, then an increase of €10 per year to around €220 would be sufficient.

Now €220 starts being the range of carbon prices that we see in many studies in terms of what could be bringing. I mean, I guess the point I'm trying to -- And these are the red lines that you see, the smooth path to net zero. I guess the point I'm trying to make is that it's one thing to impose to, to put it in place the carbon taxes. But I think we have also to have policies

that improve the choices and increases the substitutability to make sure that the carbon tax does lead to the changes we're trying to get in a relatively short time. Another point I wanted to raise, to highlight is that both papers look at the issue of international cooperation from different angles.

I really find interesting this section in Jean's paper that you just put very briefly on the implication of the departure from global carbon coverage, from the global coverage of carbon tax. This and the good discussions of the IRA and the EU Fit for 55 policy packages in both papers provide a good reminder of what the IEA has highlighted in its latest report on the world energy investment. That is that investment in renewable energy is still massively concentrated in the US, EU, and China. These are the three top countries on the chart on the left, with very little increases in the rest of the world so far.

And if you look at sustainable finance, sustainable debt issuance, you see this concentration. This is on the right side of the -- you see this concentration is even more, even, even sharper, in part because a lot of the funding for investment in China comes from government. It's the public, it's the state that, that funds this. So, these are three big blocks. But still given population trends and economic catching up, the rest of the world will still account for a large chunk of emissions moving forward and reductions from there, at least relative to current baseline.

Now, of course, EMEs can do a lot more to attract investors, starting with more stringent climate policies. But one question is to what extent this subsidy race between the three big blocks may complicate matters for EMEs in the rest of the world with respect to attracting financial flows. Certainly, it's clearly that most of these countries cannot afford the types of subsidization that we see in rich countries.

Now, given that there are generally still far more opportunities for low cost abatement in EMEs compared to advanced economies, perhaps the development of carbon markets generating carbon offsets could be a way of engineering transfer of finance to EMEs and at the same time lower the cost of achieving ambitious targets in rich countries. But we know the history of these carbon markets, and to what extent they can develop and function smoothly, of course, is still an open question, but certainly one that is discussed and very heavily and in, in negotiations, in international negotiations.

And the related question that was raised in Antonio's paper is whether and to what extent technology diffusion could be a substitute for financial transfers and a better way for advanced economies to support less advanced income countries, as the paper seems to be fairly optimistic on that. But I think that this is also an open question. To my final point on the

macroeconomic costs, because this was also covered in both papers, one final remark on this is that in various, the cost of climate policy packages in various countries that was reported in Antonio's paper and which focus on two sectors, one thing that surprised -- this was not mentioned by Antonio's.

But in reading the paper, one thing that surprised me is that when the papers moved from the CGE model to the global macro model, I was surprised to see that the discussion on investment only refers to the disincentive to invest in carbon intensive sectors. The paper mentions the decline in investment as causing a drop in real interest rates, but there is no mention of the increase in investment in low carbon technologies. And of course, it is surprising in a context where often the, the economic impact of the transition is cast in terms of a combined negative supply shock to productivity with a positive demand shock from incremental boost in investment.

So, it might be worth illustrating how the results would change. And as a reference on this, using our own CGE, climate CGE model, which provided inspiration for the EMVF model you use in your paper, so the models are fairly similar, we just made a complete, complete assessment of the EU package Fit for 55. And indeed, we find that the package leads to a decline in GDP of around 0.8% for the EU as a whole. This is the orange bar you see all the way to the right. So about two times the size of the impact you report in your, in your paper. But for the two sectors you focus on, this covers all, all sectors covered in in the EU package. But we also find that the package would lead to a net increase in investment, a small one, but a net increase.

There would be variation across countries, but. And what the chart shows as well is that the cost of the package would differ across countries. But that is, again, pretty similar to what you report in your paper, at least in terms of the difference, say, between France and Germany. We have a higher cost in Germany and France because there're more lower cost opportunities to reduce emissions there. But above all, and this is my last point, the chart shows how much the cost would differ if the package was implemented with a view in addition to achieving a common, a uniform carbon price across all sectors, but also cover gases that are emitted at the moment, especially methane.

And as illustrated with the blue bar, this would result in significantly lower GDP reductions. Now, you may think this has a flavor of going back to the elusive first best that way, but if there is one place where maybe a uniform carbon price could be envisaged, it's probably in the EU. And of course, this is model based. There's probably some frictions that are not totally captured. But it shows that there are, there is scope for reducing the cost by extending the coverage of, of the carbon prices and also trying to reduce it in a way that encourages a uniform carbon price. Let me stop here. Thank you.

Suman Bery: Thank you very much. As Jim Stock comes up, let me just ask Jean or Adam, we started at 9:25 this session. Do, do we get extra time, or is there a hard stop at 11? Because that will -- Okay. Thanks.

James Stock: Okay, great. Thanks. So, let's see. Do we get some slides here? So, this is great. So as the slides are coming up, thanks very much. I'm really happy to be able to be here, and it's wonderful to be talking about this topic. There's some great papers. This conference is really exciting. And it is wonderful to be in person again. I'm sure everybody said that, but it's worth repeating. My presentation begins by reading something on my slides that I have not committed to memory.

I will say I can tell you the bottom line from that, which is that these are both great papers. They seem like they're pretty darn different, but actually the narrative is very similar across the two. And what I'm basically going to do is elaborate on a few points on the narrative. I subscribe to the narrative between the two of these at a high level, and the particulars, there's lots of opportunities for disagreeing. So, here's the summary. So, I'm going to talk about both of these papers interchangeably because I think they're actually giving the same narrative. We know that climate change is bad, so additional policies are needed, especially in the US. Those policies must be effective and robust. They must be efficient, like Fit for 55, not like the IRA. They also need to deal with multiple externalities.

So, macroeconomists need to focus on policy solutions, not more work on damages, the social cost of carbon, and so forth. With efficient policies, decarbonization probably won't be very costly. By the way, energy security still matters during the transition. Okay. So that's my summary of the two papers, and I'm going to discuss the words in red. Okay. So, first one is what does the word bad mean? And now actually, I'm serious about, this just sounds kind of glib, but I'm actually quite serious about that because often what the word bad means is what we're talking about today, GDP.

GDP might be 4% lower. Maybe it's even 10% lower in 2100. But that opens us to a rebuttal, a really sensible rebuttal that, well, gosh, GDP itself is going to be four times higher in 2100. So, 10% off of four times higher, maybe we can live with that. Maybe 3%, three degrees is okay if it's only going to cost us 10% of GDP in 2100. I think that misses some really important points. So, I'm going to argue briefly against using GDP as a measure of the word bad or GDP debit. One of them -- and so, there's one of it is there's -- think about GDP. Just think about what GDP is. We all know what GDP is. Think about a hurricane. Hurricanes, it's kind of ambiguous, especially small hurricanes.

Their GDP effects are kind of ambiguous. It goes and destroys a lot of stuff. You know, you have to, but you get to rebuild it. And that rebuilding goes into GDP. There's some allocation across sectors. Some people are killed. Eh, you know, but, you know, in the long run, but, you know, it sort of evens out. So, hurricanes, maybe they're not so bad for GDP. Maybe they are. But, you know, you get these costs. So actually, you go through it and there's a lot of stuff in GDP that isn't really getting at damages.

So, damages are different than GDP. Damages we can think of, well, you know, we actually lost that, we lost that, those things. If somebody, if some old folks died in Seattle, that's not such a big deal for GDP because they're not super productive and their assets pass along and somebody else gets to consume out of that. But we might not think it's great from a welfare or damages perspective. You can monetize those. That actually goes into the modern calculations of the social cost of carbon. I will push back strongly against Jean in terms of the quality of the work and the social cost of carbon. Go read the current literature, and there's a lot of great thought in it. Is it clear? Is there ambiguity? Is there uncertainty? Of course, there's a lot of uncertainty. But it is pretty -- it's very careful science. Even that doesn't take into account a lot of things.

The conflict, migration, natural capital costs, species loss. You can go down this list, how we think about rights of nature. I actually think there's something, I actually subscribe to a lot of these concepts. Species lost is not something that's easily monetized, but these are actually responsibilities that we have to the earth and responsibilities that we have as co-animals with other animals on this planet and responsibilities that we have to future generations in terms of passing down a legacy that we've, we've thrived on for hundreds of thousands of years.

So, I think that it can -- GDP, when you start talking that way, GDP seems like kind of limited. So, I think that we just need to bear that in mind. Okay. Comment number two. I agree completely that the IRA isn't enough. I'm just illustrating that with a picture from a recent EIA, Energy Information Administration report a few months ago. And you can see that they estimate the IRA to have, excuse me, decreased emissions in 2030 by perhaps ten percentage points. There's a bunch of other papers out there. There's a really nice one by Bistline et al. that might come up in other discussions. That these estimates of 7% to 12 percentage points decrease in emissions reductions as a result of the IRA, that's great.

Of course, what jumps out at you is that ghastly straight line going on beyond 2030. And however you approach this, if you approach this through a social cost of carbon perspective, if you approach it through a net zero target perspective, it doesn't really matter. You don't have to argue over whether you like one methodology or another methodology, that blue line

or that straight line, that line out there to 2050 is not, you know, the path that we want. So that raises the question of what the next policies are going to be. Oh, I think I might, in the interest of time, skip over some of this slide about the IRA. I think the basic point on the IRA here on this slide is that it is cost beneficial from a cost benefit analysis using the social cost of carbon. It is not efficient.

This is actually worth pausing on. So, in the traditional use of cost benefit analysis for government regulations, we apply a cost benefit test. That's great from a marginal perspective – the benefits exceed the costs. I think that one needs to rethink that, not because of problems with the benefits calculation, the SEC, but because that's only a step towards a global solution. We're actually facing a non-marginal problem, and a sequence of marginal decisions that are cost beneficial might end up being far more expensive than what we really can afford given an overall budget constraint.

So, if we think about the folks who've really been worrying about, you know, think about Summers' speech here, Larry Summers' speech here or whatever, a week or so ago, worrying about, worrying, excuse me, worrying about overall fiscal discipline and fiscal budget constraints. We can't keep passing trillion-dollar IRAs again and again and again. We're going to have to figure out more cost effective, efficient policies rather than choosing policies that pass the cost benefit test, as does the IRA. Okay. So, I'm going to skip over all of those slides, the numbers, because the numbers say what I just said in words.

This just says we've got a long ways to go, and a small carbon tax will really make a, would really make a big difference. Actually, I'm going to pause on this point for a minute. I actually think this is a really interesting point that we're in right now in the United States in terms of climate policy because we've just passed the IRA. There's a huge amount of cheerleading on the progressive side. There's a huge amount of moaning on the Republican side, on the, on the conservative side, on the, on the more extreme right side. I'll put it that way. Not in the centrists, not in the centrists, but the more extreme right side. And, but we're not, but we're nowhere close to enough.

We're actually right now, for the next several years, a carbon price would not actually make much difference in the power sector because we have all of these subsidies in place. For the next several years, a carbon price would make any difference in terms of light duty vehicles, whether you're taxed, whether your gasoline is, what, a little bit more expensive. We're going to be going into light duty vehicles anyway. Where carbon price is really going to start to matter is in the 2030s and 2040s when we need to have something that really is going to drive home and solidify the use of alternative technologies for the hard to abate sectors.

Once we have alternative policies that and alternative technologies in place, a carbon price in 2040 is going to be really important to make sure or clean aviation standard or something like that. But I prefer carbon price for the obvious economic, economist reasons. This is a great time to put in place a 15 cent carbon price that grows at 2.5% per year. So that's the message there. Energy security. Usually, economists start to squirm at the words ‘energy security’ because it suddenly takes, it takes all of the stuff we understand, and somehow the international relations people grab onto it and says these are quantity problems and oil gets locked in. And then you hear these other words about demand destruction.

And we don't know quite what to think about it. But really, it's all just about, when people complain about energy security, it's really just prices have to be low and stable, you know. So, what are the threats to low and stable prices in the clean energy transition? Some of those threats are really quite dramatic as this picture is. And I think we need to be really attuned to that going forward. Okay. I do not subscribe to the -- I'm going to take a little bit of issue with -- I'm going to actually subscribe to a part, but then, you know, disagree in part with the, with the IMF paper. Okay.

So, one of the things I'll agree with is that we should expect, continue to expect on transition geopolitical and other things that are going to be, depends who you say. Economists would say high and volatile prices. The IR people would say energy security. We sort of mean the same thing. Okay. So, you can just see what -- I'm going to make this pitch that this is actually really widespread. The pitch is it's not just oil prices. It's oil prices, it's actually all fossil fuels. So, I'm going to make a little brief digression here that all these fossil fuel prices are linked, including in the United States where oil and natural gas prices, I believe or I will argue, are linked. Okay. So, the slide on the left, just to remind you, if you don't really know, is that oil prices and natural gas prices in the EU are highly linked historically.

Actually, that's true globally in terms of the global LNG market. Global LNG is actually often indexed to oil prices, and that's because they're substitutes in production for a variety of different places, especially for electricity generation in Asia. I've excluded the Ukraine crisis from the picture on the left because, you know, things went berserk for special reasons during Ukraine. But now we're going, we're getting back to this co-linkage, this historical linkage. What people don't realize is that they have become linked in the United States. And so, I'm just asserting that there's like some econometrics and things like that on the, behind the picture on the right.

The reason is, is that we are now exporting 10% of our LNG, of our gas as LNG. That's probably going to be 20% as soon as two years from now because of really interesting new technologies like floating storage and

regasification units on the bottom and fast LNG terminals on the top. So that means what we see empirically at the picture on the right is that we have re-linked US natural gas prices to global prices with a decrement because we're exporters, and so somebody else is paying for the LNG, the gasification, regasification costs. This is the most amazing picture.

This is just amazing. Because you think of coal, how could coal have anything to do with anything? The top is coal. The top is coal prices, US coal prices, and the bottom is, the bottom is Henry Hub prices. And you can see that even US coal prices in Indiana are comove, comove, and I'm not doing the econometrics here with, with Henry Hub prices and with natural gas prices, and that's because these are substitutes in production for electricity. So, is that going to change? So then this is the major one point.

So this is agreeing with the energy security risks going forward. We're going to have lots more as we have international transitions and as we have oil states becoming less powerful. I think we have more unfortunate events in our future. I don't think this is going to disappear. Let's just pause and think about these holy grails of hydrogen, green hydrogen, green ammonia, and so forth. What are those for? Green hydrogen? Well, it has so many great uses. That has so many great uses. Well, that means it can be used as a storage replacement, like as a long term battery storage for electricity. But it means it can power steel mills, which means it can power and maybe it can even be used for airplanes. Or you can go from power to fuels via hydrogen.

So, you can either take that hydrogen and then you can turn it into a jet fuel. And the green ammonia can also be used as a storage facility. I've just said that it's a substitute in production for oil and natural gas with CCS in 2050. That means all these prices are going to be linked. So, I don't think that we're getting rid, and they're all being transmitted to the power sector and because we have marginal cost pricing. So, I don't think we're getting rid of energy price volatility like in any of our lifetimes or in our kids' lifetimes. I think this is just going to be here. So, I think there's a false narrative or a fallacy.

Final comment, and I'm out of time in 30 seconds, final comment, what should macroeconomists be doing about all of this? I completely subscribe to the Swedish paper, that I think it's time to move on. We've done really great work on things like the social cost of carbon. It's fine to keep doing some of that, but I actually think that it's time to like refocus our attention. We know climate change is bad. It's worse, much worse than our calculations of GDP would suggest. There's many more responsibilities that we have to deal with climate change. We need to have robust policies. Okay. We get that. We need to start thinking about how to deal, how to think about what those policies are at a high level of granularity and a high level of specificity.

So that's sort of taking, agreeing but sort of going one step beyond the Swedish paper. I also think we need to be starting to think much more about a lot of these short term transition risks as from a macro perspective, from a macro policy perspective. So that's in this picture right here, in this lower one that is like all these human system risks. I think we need to be taking those really seriously. Those are potentially major impediments in the energy policy transition. I think we can expect to have more of them. I do disagree with Jean.

Let me double down on the disagreement, Jean, about whether or not we have tools. I mean, we've been doing that looking at, you know, using time series econometrics tools, because that's kind of what I know, looking at, looking at policy uncertainty, looking at these natural gas pricing changes and that sort of thing. We have other tools, more sort of theoretical tools. I think it's just a matter of people taking the tools we have and focusing on these really hard problems. It's much harder to think through these short-term human system transition risks than maybe it is sea level rise in 2100. So, I think that's a really important frontier for us to be working on. Thank you.

Suman Bery: Thank you very much. My thanks to both the discussants. May I ask the panel to come back on stage? I think the guidance I was given was discussion with, among the panel and then go to the audience. But in the interest of time, let me reverse that. Let me take two or three questions from the audience first and then refer them to the panelists. So, if you could indicate which panelists you wish to answer. And then towards the end, I'll cut that off and maybe add a few of my own reflections based on this. So, who would like to lead from the live audience here? Jean, you? Okay. I think Jean needs no introduction. But others, I'd request them to introduce themselves.

Jean Pisani-Ferry: So, thank you. And thank you for the presentation and the start of the discussion. Let me make just two points. One, on this, this issue of the whether we have the right toolbox or not. I was not saying we don't have the right toolbox in general. I was saying we don't have the right toolbox to think about the linkages between macroeconomic policy and climate policy. And that's a different issue than the issue that was just discussed. I mean, for most people doing macroeconomic policy, climate is beyond the horizon. And the question is how to bring climate within the horizon. My second point is a question to Jean. I didn't really understand how he can say at the same time that a small tax would do the job and that the cost of not having the tax at the right level would be, would be massive. It seems to me that the implicit assumption is that the cost of adaptation is much higher than the cost of mitigation. Is it correct?

Suman Bery: So, I see embedded in that a question really to Jim Stock and to Jean. May I get one or two more questions from the audience? Anybody? At the back, please. And if you'd kindly identify yourself. Yeah.

Speaker 1: So, a couple of questions to John [inaudible 1:47:07-1:47:14] missing or commenting on. One is what, you're basically saying -- Non-linear. Thank you. Okay. So I go to the mic and then I will use it. You're basically saying that the nonlinear change in climate, that it is basically going to be proportional and everything's going to be kind of more or less predictably linked to CO2. I would imagine that, I mean, the kind of feedback loops that you're kind of rolling up are, are ruling out, kind of the ice cap melting, et cetera, are a big part of the uncertainty that you were mentioning.

Why this kind of assumption, apart from obviously being convenient, why does this assumption, uh, kind of play, play such a big role in the analysis? And can we maintain the kind of analysis we're, we're trying to undertake on this GE model without it? A similar kind of but on the other direction is your similar non-linearity, potentially big, big shift on the green versus brown economies, versus brown technologies. We are seeing gigantic and unexpected, as the IMF team said, changes in solar.

We might see similar things in batteries. If we see really that development in batteries, which is obviously very uncertain, um, would we not suddenly see a much larger transition than you are predicting? And are there reasons to rule that out on the basis of what we are observing? On basically, we observe it in, in photovoltaic, we observe it in wind, we are observing in batteries. We're basically observing these very large surprises on learning curves on essentially all of the clean technologies.

Suman Bery: Sorry, is this a question about uncertainty or about technology? Luis?

Speaker 1: Yes. This is a question about the speed of substitution of green by brown and the kind of, the, the essential pessimism that the paper was, was manifesting on that.

Suman Bery: Yes, I have here questions for John and I think for Jim. Is there a question for Antonio anywhere in the in the room?

Speaker 1: [inaudible 1:49:38]

Suman Bery: Okay, fine. Yeah. Okay. So who would like? John?

John Hassler: So, what I illustrated in the, with, what, in, in the paper is that the, the, the marginal effect of taxes on emissions is fairly high in the beginning, and the cost is low. So, that €20 tax that I had in the paper had a substantial effect, but it's not enough. So, I think that a reasonable strategy is what we are doing in Europe now. And, and, and, and that's a pretty strong policy. It actually covers something like 99% of CO2 emissions, 90% of greenhouse gases, but it's CO2 emissions that have this cumulative effect. So that's where it makes sense to have a cap and trade system. When that was introduced, when the increase in the speed at which we are phasing out emission rights in the EU ETS was increased.

That was a pretty dramatic thing. Now in the steel industry, the cement industry, flying within Europe and so on, it's not going to be allowed to use fossil fuel after 2040. So, when that dramatically or pretty abruptly was introduced, the carbon prices, the emission prices increased by a factor four. But I would say that's not very high, even that. But, but certainly, we're going to need more than €20. When it comes to that asymmetry, I think, I think what we, the potential costs of not doing this, that comes from assumptions that are kind of the upper range of climate sensitivities and possibilities of adaptation. And what we argue is that we cannot really prove that it's necessary to do this phase out of fossil fuel, but it can turn out that we, in the end, regret not doing it.

But we argue that the transition to climate neutrality over three decades can be done with relatively small cost because the economy is flexible if it gets to steer in the right direction by credible policy commitment to climate neutrality. So that's kind of the point. When it comes to the -- I have to answer the non-linearity. I think that was important. I'll try to be short. The non-linearity, the non-linearities and tipping points is actually in the IPCC report ruled out in the global climate system, and that takes into account also feedback mechanisms like the ones that you were talking about. It's certainly not possible for me to go into that discussion.

I think as social scientists, we have to trust that IPCC provides a consensus view with lots of variations on these issues. So, it's certainly not my assumptions. We, in the paper, we provide references to exactly where this is stated. There are substantial, important potentials for regional, uh, tipping points. So, for example, it's been mentioned, mentioned the Amazon. These are possible and perhaps even likely, and they operate, some of them, including, for example, the Amazon, on a relatively short time scale. We're talking about decades, not, not, not centuries like when we are talking about ice caps where it even can be millennia.

Suman Bery: Again, I think, may I --?

John Hassler: Just 20 seconds on the green brown.

Suman Bery: Okay. I think I exceeded your budget.

John Hassler: I think that history has not really shown that there is a clear tipping point just around the corner. That's what we are saying. I hope that it might come, but I don't think we should put too much faith in it.

Suman Bery: Okay. Could I ask you, Jim, to talk about the models?

James Stock: I'm just going to, I'm just going to talk about one little thing about the models here. I didn't want to make too -- I shouldn't have made too big a deal about this. I think that, like, the allergic reaction might have been tools. I think we have some really strong tools for short term macroeconomic analysis. One of -- a family of well-developed time series econometric tools, families of well-developed stochastic general equilibrium models, DSGEs, et cetera, et cetera. Those models have typically not been used to focus on things that we might think of as climate macro connections.

I think that's just a matter of having the horsepower. So, I don't think it's like we somehow need to invent a new family of tools. We just need to refine those tools and get to work on doing all of this. We saw examples of that today in John's paper and the Swedish paper. We've seen examples. There's a great example of a build out like that in the Bistline, Mehrotra, and Wolfram Brookings paper from March.

There's a lot of other interesting work that's fairly nascent. I have some really, there's some really interesting work in this dimension by some, a junior colleague of, of mine. Anyway, so I think this might be a terminology thing. But I think there's a ton, the main point is there's a ton of work that can be done and needs to be done in this area.

Suman Bery: Okay. Antonio?

Antonio Spilimbergo: Yes. I will take up two issues. One is about the right toolbox and the other is about energy security. About the right toolbox, I would distinguish before the recent shocks and afterwards. Before we had a kind of naive view. We thought that engineers would tell us what is the damage. They would give economists a number and say you have to reduce CO2 by X percent by that date. And we, as economists, had to rely on our model econometrics to design the optimal policies.

This was, so a clear division of work. I think that doesn't work. It doesn't work because we learned that the political economy constraints become much more binding at a certain point or other considerations, both internal opposition and the energy security that introduce other objectives. So, we

have to a little bit enlarge our toolbox to include also that. It's a little bit like we did in monetary policy.

It's not enough to, to study the transmission mechanisms of monetary policy. It's important to design institutions that guarantee that you solve issues like time inconsistency. So, we are just focused on that. And we forgot about the time inconsistency and the political economy. Of course, the time inconsistency in terms of climate policy is much bigger problem.

But we are here for that. Second issue, energy security. Maybe I was unclear in the paper. We are not saying that energy or price of energy will go down, will go, will be less volatile. What we should stress is the source of volatility will be different. As in the past, the source of volatility will be that some scarcity, some shocks. And since the price source of energy are cointegrated, they will be transmitted like this. But there is another source of volatility which is even more interesting, is the policy volatility. Unlike previous transitions from coal to oil, oil to gas, this transition is not driven by relative scarcity of source of energy. This transition is policy mandated.

And so, this introduces another source of volatility, because if policymakers, for some reason, like we had recently, changed their view, you had in the short run different shocks, which are not driven by the sheer economic of relative scarcity. So, this complicates a little bit. So, it's a new source of volatility. And we have to design, and this goes back to the previous issue, where to design institutions such that the source of volatility is minimized.

Suman Bery: Okay, good. Alain, would you like to talk to the technology and battery issue?

Alain de Serres: Well, just maybe one, one quick, my two cents on, on the tools. And I think where we need to, to improve is to find better ways to connect what we learn from very detailed sector model, almost engineering model in terms of the path we need to follow to achieve certain amount of reduction in the specific sectors and link that to model, maybe CGE model that gives us more general equilibrium, takes into account the feedback effect and the rebound, but also that gives us better insights in terms of what types of policies then will induce the change in behavior and the, and the change in to arrive at these, to make these paths possible other than through regulations.

Now, there's quite a lot of improvement that has been made in going beyond simply carbon tax or certain types of subsidies in terms of capturing the impact of policies and models. But I think there's still work to do to better understand how we can connect that, what we need to achieve, where we need to go. And then how does that translate in the right types of policy to make them as efficient as possible?

James Stock: Can I just jump in and add one more comment on the energy security? And this is something to underscore something in the IMF paper. They make a really important point. And I think as economists, we would get this like instantly. But it is absolutely worth repeating in this world. There's this fallacy or this phrase of worrying about, for example, you know, China becoming the OPEC of critical minerals or Chile becoming the OPEC of lithium. That's just not the right way to think about this problem.

There's a fundamental stock flow difference between, for example, lithium and oil. Once I've got that solar panel on my roof, Chile can do whatever it wants with the lithium price. And I've still got the solar panel on my roof. It's not like the car where I'm paying every, every day. So, okay, everybody in this room gets it. It's just worth repeating because you hear this phrase a fair amount.

Suman Bery: Could I just, you know, use my prerogative as chair to ask, and maybe Antonio would have a view, so what about the green paradox and the notion that basically, the world is not going to run out of stones, the world is not going to run out of oil. So, what's the policy framework for, as it were, preventing that from becoming a source of uncertainty for the transition? I think John also had a point. But Jim, could I start with you and then maybe Antonio?

John Hassler: Well, the green paradox. Jim. Okay.

James Stock: So yes, so I think so the question here is, is the amount of, as the demand for oil gets low, then the price of oil is going to drop, and people are going to be using a lot more of that. That's what you're referring to. Okay. So, I think that there, there's only two possibilities, it seems. And one is either you encompass all of the oil into the, into some sort of comprehensive policy, either a carbon tax that's increasing or sectoral policies such as a clean aviation standard, so that you have to, you ensure that that has to, the package has to be oil plus say direct carbon removal or something along those lines.

I mean, that's we're looking at pretty far period out. The other policy option is to remove the supply curve in. We have tried that. There was, there's been valiant efforts over the last ten years to move the supply curve in in the United States in terms of fossil fuel leasing reform. That effectively has been a political complete failure. So, this administration came in with very ambitious goals for fossil fuel reform, reform of our fossil fuel leasing program. Those basically have been completely abandoned and replaced by demand side policies. If you take that as a view of just the difficulty of the political economy of this issue.

Suman Bery: Yes, sir. But --

John Hassler: The green paradox applies to fuels where the price is mostly rent. Right? So that, and it's clear that it's going to be very difficult to price out those kinds of fuels. So, the Saudi oil is going to be used up. Fortunately, it isn't enough of that to pose a big climate problem. I talked about it, but it got missed maybe in my messing with the clicker. But no. So, and it, it's very easy. You see it immediately in the models. That those, those fuels that are, you know, low cost extraction, it's very difficult to not having them all used up. But fortunately, it isn't enough. Fracking, coal, and non-conventional sources, there the price is largely cost, not rent. And then the green paradox doesn't apply at all.

Suman Bery: Okay. Yes. Did you have, Antonio?

Antonio Spilimbergo: This green paradox, there was also another source of transition. And usually, we moved from one source of transition to the, to the other because the technological progress in the new source drove down the cost so much. So, the world moved from sale -- not bought with coal not because wind became too expensive, of course. It moved because technology advanced so much that at a certain point. So, I'm hopefully confident that the technological progress will naturally price out Saudi oil.

Suman Bery: Okay. I don't think we have time to go back to the audience. So, I would now just like to offer some reactions of my own and then go perhaps in reverse order through the panelists and discussants. But as I do so, let me say I'm not going to attempt a summing up, but I do want, at the end of this round of discussions, that you join me in thanking the, the panelists and the discussants. I think this session was meant to be a scene setter, and I think it has done that, which is on the macroeconomics of climate change. But on that basis, I'm going to raise my question to the panel and give each of them in their own way an opportunity to respond if they so wish.

And there's no secret about the fact that I'm listening to this as somebody not from the US or the EU, but from, from a large emerging market. And I guess I have two broad points. One is the conference is the macroeconomic implications of climate action. But what we've largely heard about is mitigation. And so my question is where in the overall discussion of these two countries does adaptation lurk? I think we got a little bit of that in both of the discussions' comments. But both as a political issue and as a public finance issue, is it as important? And I guess we had one slide which indicated that the adaptation costs, if I could call them that, are rather different from Northern Europe and Southern Europe.

And I would just say that this is something I'm going to talk about in my session at the end, which is that regional and spatial dimensions are very

important for domestic political economy. But we've really been talking about, as it were, at least nation states as, as entities. So that's question number one. Should the macroeconomist tool book also comprehend adaptation? And the second point, and perhaps this is more directed directly at John, you know, I do have -- you do point out early on in your presentation that what we've got is a stock problem and not a flow problem in terms of carbon accumulation.

And yet you were rather, I would say, quick to characterize certain countries as climate laggards from the point of view of, as it were, their contribution to mitigation. And so, I can just say that a lot of the perspective of emerging markets is on the stock rather than contribution to the flow. And I just wanted to make that point because that gets into the issue of burden sharing climate justice, which actually, maybe ethical, maybe not macro, but it's certainly important if you want to enlist the, the support of the emerging markets. So having got that off my chest, the final round, let me do it from extreme right to -- And you respond, John, when it's your turn. So, Jim?

James Stock: I'll be really quick. [inaudible 2:07:51-2:07:59]. Okay. Left or right? Depends on where you're sitting. Okay. So, I'll just be really quick on the adaptation. I think that's actually a fascinating question. So, understanding, understanding adaptation costs in the context of, you know, whatever your macroeconomy actually is, like if we're thinking about developed economies or the United States or Europe or something like that, then sort of thinking about those adaptation costs is actually something that we haven't fully done. Surely, there's going to be a productivity hit because you're redirecting capital and resources into basically something that wouldn't otherwise, you wouldn't otherwise optimally allocate them to. But I think that's a great area for research and trying to figure that out. So, I guess that's all I would comment on that.

Alain de Serres: Yeah. I would say that, in fact, I would go further than, than the importance, of course, of, of thinking about adaptation and going beyond and other environmental issues related to biodiversity, as I mentioned, but also water desertification because I think this may all be connected in some ways. And I think it's important to think when we think about solutions for climate mitigation that we take into account as well these dimensions starting with adaptation.

I mean, we shouldn't attach necessarily too much importance to issues related to things like nature based solutions, but at least there's probably scope there to see what can be done, especially in areas where the degree of emissions at the moment is very low but bound to rise rapidly. But where there's still possibility to put in place relatively low cost solution to avoid a big ramping up in emissions. I'm thinking about Africa, for example, where

they can leapfrog some technologies, much harder in other parts of the world, like Asia.

And there it relates, I guess, to your question about they're not responsible for the stock of emissions, but they will be responsible for the bulk of future emissions. And therefore, it's absolutely fundamental to find ways to, and of course, this is the object of difficult discussions at the international level, but to make sure that they get the flow of finance that is needed for them to also implement solutions.

John Hassler: On adaptation, I certainly agree with what you said, that it's very important to bring that in. And both because, I mean, it tells you something about the actual damage that climate change has. I mean, if you think of a concrete example, sea flooding, if you think that sea flooding is very costly, then the marginal cost of climate change from that mechanism is really about the cost of building seawalls. So that's one thing.

The other thing is that, of course, there are impediments to these kinds of adaptations. There can be moral hazard, there can be financial issues and so on, and we need to think about how to overcome them, them. That's, I think, extremely important because adaptation is going to be very important. When it comes to climate justice, I think it's clear that we in the rich world have a larger responsibility than the poor countries for making sure that we become climate neutral in good time. Should that come through us going much faster in reducing emissions?

I don't think that's the right way. We argue and we would like to see more research on that, that transition to climate neutrality over 30 years is not very costly. If everyone does what the EU does in terms of the budget per capita, then we are fine. Should, should we then, because of justice reasons, go much faster, do it in 15 years or so? No, that would be extremely costly, practically impossible. And it would buy China or India a year maybe or so. But they would need to do the same thing anyway. So, it's a very bad way of showing climate justice to go much faster than in, than something like an equal per capita to carbon budget.

Suman Bery: That's insightful and illuminating and obviously a field for research. Antonio.

Antonio Spilimbergo: Yes. I will give an institutional answer. At the IMF, since last year, we have a facility called the RSF, Resilient Sustainability Facility, which is aimed exactly at giving financial, financial resources to countries to facilitate the adaptation, recognizing that adaptation means a lot of upfront cost, which these countries don't have. The challenge we have is that the resources are limited, and so we are looking at a way of leveraging on these resources to bring in some private capital exactly to -- the obstacles are both financial

and both time horizon of politicians, which we know that they are reluctant to act [inaudible 2:13:03].

On the justice, I think that we should explore some form of technology transfers. This could help in the sense to avoid also the green paradox you were mentioning before. After all, naturally, countries, low-income countries adopt the technology from the north when the technology became cheaper enough. And the issue is how to speed up this natural process, which is what happened in the past. Now the policy challenge is to make it even faster.

Suman Bery: Good. Well, please join me in thanking the excellent panel. Let me hand you back to the organizers for the time check. So thank you, John.

Antonio Spilimbergo: You were benevolent—

[End of transcript 2:14:21]