



Conference Transcript

The macroeconomic implications of climate action

Session 5: Panel discussion: Climate change and macroeconomics: Where do we stand?

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Jean Pisani-Ferry: Okay. Welcome, everyone, to the second day of the Peterson Institute's Climate and Macroeconomics Conference. We had a very fruitful first day, but we start with a with a panel in which I think it would be useful to recap a bit what our takeaways from the first day are, where we find that we had agreement or disagreement and what are the questions that remain and that should be addressed in the second day. So, that's what I'm going to do with a panel composed -- let me just take my [inaudible 0:00:54]. Sorry for that.

A panel composed of, in the speaking order. Christiane Nickel, the Head of the Prices and Costs Division of the Directorate General for Economics at the European Central Bank. And she has made a career with the ECB, and she holds a PhD in economics from the Koblenz University. And so, she will be speaking mostly about questions of what the counterfactual and which I think is really appropriate because we did not discuss that so much yesterday. Then the next person to speak will be Jennifer Harris. Is she here? She's not yet here. Okay.

So, if not, it will be Beatrice Weder di Mauro, who is the president of CPR. And she's been president since, well, 2018, which is already some time. And she's made a number of changes at CPR, not because they were necessarily indispensable or urgent because she thought CPR had to adapt to the new context. And I think those are very welcome changes. So, she will be speaking mostly also about questions of adaptation, but also more broadly.

And then Jennifer Harris, who served as a special assistant to the President and Senior Director for International Economics on the National Security Council under President Biden until the recently until March. So, she will be speaking largely also about the choice of instruments. So, let me suggest we move to the to the table so that I'm not alone and we can have a dialog on the takeaways from the first day. Shall we?

[Audio gap 0:03:40 - 0:04:04]

Can you just move the clicker? We do have a clicker. Don't worry about that. Let me start with a recap and discussion about what we learned yesterday. So, yesterday was a very full day, a very rich day. Microphone. Okay. Yesterday was a very full day, very rich day. Good morning, Jennifer. And I think we learned a lot, but we still have many questions that are to be addressed. So, the questions are about the overall impact of climate action. There are different perspectives.

We had this first session on the overall impact essentially based on model simulations and on discussion about the effect. Then we had this speech by Pierre Wunsch, who also addressed the problem in its entirety. And then we had three specialized sessions, one on productivity, one on fiscal dimensions, and one on labor and capital market relocation. But in fact, it was mostly on labor market relocation. The key takeaways for me, first, that there is remarkable optimism about the long-term. Nobody said, "There is no solution in sight. We should go for degrowth, or there is a contradiction between growth and climate change mitigation." There was remarkable optimism in this regard.

And this is perhaps not a surprise given the composition of the group. But this is something that should be underlined. The first perhaps discussion was the one I launched, inadvertently when I said, "We don't have a proper toolbox. We don't have a proper analytical framework to think about those issues," which elicited a strong rebuttal by Jim Stock and also by Jean Hassler, who said, "Yes, we do have the instruments." And the question is how they're being used by policy makers. That's something we may wish to go back to. Although Jim Stock is not here today.

The third point, there is considerable variants as regards the orders of magnitude we're speaking of. Let's mention two numbers that were indicated. One is the fact that a global tax to the tune of 20 dollars per ton if applied overall, generally would go a long way or even would do the job of addressing climate change and limiting the rise in temperature. That's Jean Hasler's estimate. Now, another number which was mentioned was this 300 euros, I think, or dollar. It doesn't matter so much per ton for the marginal technology that was mentioned by Pierre Wunsch.

So, here we are facing sort of a major discrepancy in the quantitative estimate even if we agree on the analytical framework. By the same token, there is no agreement I can see on the output cost of the transition. Some said it's trivial or even it's positive. Some say it's going to cost significant output. And here I'm referring to Philippe Aghion's paper and his view that redirecting technical change will cost inevitably something in the short term. I mean, even in the medium term in our sort of traditional naming of the time horizons. And so, that's one view.

The other view being that we're speaking of a trivial cost. So, that's a different and important discussion. There has been an important discussion on the choice of instruments to steer the transition to dirty to clean. These overall, I think the idea that we need more than one instrument is largely accepted. But how to use these instruments is a discussion we need to go back to. Because there are different arguments for having more than one instrument. One is that there are different externalities to deal with. One is that there would be learning. One is that there is uncertainty.

So, all that doesn't translate into a precise roadmap for using the different instruments. It was mentioned that the subsidies are effective, but that the abatement costs corresponding to subsidies is much higher than for taxes. And then there is the question of the sequencing. If you go for two instruments, at what order should you go? Steven Fries for example said, since you start with subsidies you're going to adapt.

The capital stock to capital stock is going to get greener and therefore further transformation is going to be easier. There was less of a controversy on the two other issues that we discussed, the fiscal issue and the labor market issue. On the fiscal issue, the paper by the IMF, the paper presented by Ruud de Mooij and written jointly with Vito Gaspar is an attempt to find a global solution to the problem. So, it's a very normative paper, but it comes up with estimates of the cost of doing so that are relatively benign or very benign.

And in the discussion, Selma Mahfouz compared those costs with what concretely is the cost of moving to a different system by letting households buy cars, electric cars, by letting them change their heating system, by letting them insulate their houses. And the cost of those investments are really much higher than those presented in the IMF paper. So, that's a discussion we may wish to go back to. And finally, on labor markets, labor markets that was the topic of the paper by Robert Lawrence. There was also a paper by Stephane Hallegatte on the different ways of addressing the issue of the transition in different countries.

But the agreement there was on the labor market dimension was remarkable. It was largely agreed that the cost would in principle be small. But that those small cost could represent very significant obstacles on the way to the transition because that was a trauma of the of the China shock, if you wish. And the fact that the China shock was regarded as very small, the mantra of trade economists had been that the relocation would take place, not in a completely frictionless way, but without too much trouble.

And in fact, the consequences of the China shock in the US, but also in Europe had been major, so the economic and the political economic consequences. So, I think there is a lot of attention on how to minimize this

cost and how to support relocation being known that if you enter into detail, this is not an easy thing to do because those jobs tend to be geographically concentrated and there was an interesting discussion on place based versus person-based policies.

So, there is still, as you see, much to do to narrow down the differences. The perspective is the easy common perspective, if you wish. But there is much to discuss in terms of the details. The question obviously is that this need to act without delay and acting without having a clear perspective on what are the costs, what is the right instruments, what are the priorities is as always a challenge.

But I think the different challenge we are facing and that a challenge I would wish this panel to discuss. So, perhaps those who were here yesterday, those of you, Bea and Christiane, if you wish to react and give your takeaways or dispute my takeaways, please do. Bea.

Beatrice Weder di Mauro: Well, Jean, it's always hard to disagree with you. And in fact, I have prepared a few slides that largely agree with some of the takeaways that you have given in terms of the macro. I would, however, emphasize one thing that we have not discussed enough so far, and that will be in my view, major going forward. And it is the distributional consequences not only within countries.

So, those are the ones that you just mentioned, labor markets and their trauma from the China shock. And is there a new transition shock coming of the same type, but there is also the distributional consequences across the world. And I'm talking here about how are we allocating the remaining emission rights? Who gets them? Very simply saying, I have a little slide that I can show afterwards on this.

Christiane Nickel: Thanks a lot. I mean, one reflection that I had after this day is also how well the papers flew into each other and basically set a whole room of policies that we would have to think about in the transition so that we cannot say, "We have carbon prices," and then this is the end of the story. I think this is what actually also was said yesterday. But it's even more that we have to think about the labor markets and past structural policies. We have to think about innovation. We have to see how fiscal policies can play a role in, for example, also fostering investment and so on.

So, there is a whole, let's say, range of policies that would play a role in this whole transition. And therefore, I mean, given this uncertainty that we are facing, we have not really also, let's say, much time to dig ever deeper into the analysis. And that is the other thing that I thought of yesterday. And I mean, at the ECB, we have, with the arrival of Madame Lagarde, started a whole process of bringing in climate change, thinking into our daily work.

And I can say that also over the last three years in the ECB, but also what I've seen in terms of research here, a lot has already happened. And I would also say that a lot of things we already have in our toolbox, and it's now more about also trying to bring in maybe the angles from maybe meteorologists from other researchers into our work that we have already done as economists.

[Audio gap 0:18:21 - 0:18:38]

Jean Pisani-Ferry: Yes. Sure. Okay. We can move. Okay.

Christiane Nickel: Okay. Mic is already on. Thanks a lot. So, first of all, thanks again for the conference organizers for inviting me to this really so far very insightful conference for me. Now, we've already said that this conference focuses on the macro implications of climate action. And I will also come to this point when we have then later on a discussion among us. But before, I would really like to take a small detour and speak about the macro implications of the changes in climate that we are already seeing, and what will be likely see also in the future.

I mean, some discussions yesterday have already basically touched upon this. So, this is a bit of a link between yesterday's and today's session. I believe it is important to bear in mind that what would be the consequences of the absence of forceful climate action. And as we also saw yesterday, climate change action, and climate change happen at the same time now, and going forward. So, that means you cannot really separate the climate change from climate change action.

And this is why now I will focus my brief intervention on a relatively small or still young strand of literature on the impacts of climate change on inflation, and looking at it from my perspective as a central banker. Now, before getting into the details, this is the usual disclaimer just to say there might be some overlap with the European Central Bank at least so. But they should not be taken, let's say verbatim as the views of the ECB central bank. So, now turning to my first slide, the temperatures, I mean, this is a well-known slide from the IPCC report.

And what we see here is that the temperatures across the globe have been increasing, and climate change has started making weather extremes more widespread and pronounced. And you can see this in this illustration, the famous warming stripes that you see here represent the annual average warming. And you can see increasingly more orange shades in recent years. And from the increasingly red colors going forward, you can also see that warming will continue in every scenario, even with the most ambitious emission reduction and transition policies from now on.

This scientific evidence on scenarios of future climate change underpins what the President of the European Central Bank has said last year. If we do not account for the impact of climate change on our economy, we risk missing a crucial part in our work to keep prices stable. From a central bankers point of view, it becomes increasingly important to integrate climate change in our work. This includes not only the impacts of warming, but also the impacts of climate action. This is because it is difficult to conceive a scenario in which the impacts of climate change and that of climate action on our economies do not increasingly matter.

Now, let me briefly get back to the impacts of warming on our economies. Our understanding of macroeconomic impacts of global warming is underpinned by the literature. It shows a well-documented relationship between increasing temperatures and declines in economic output. Many different relevant impact channels are documented by now. Yet the literature that specifically looks at the relationship of climate change and inflation is still relatively nascent.

There is now some evidence for inflationary impacts of hot summers, especially in warm countries. But there is also some evidence for demand side effects that may lead to downward pressures on inflation. We've also published a working paper on this recently, and I will now briefly go into some of the findings. If you want to look for it, it's an ECB working paper number 2821.

Now, our paper adds to the empirical evidence on the climate inflation relationship, where we find that temperature shocks have non-linear impacts on inflation. We find this based on global panel regressions which show that the inflationary impacts of temperature shocks depend on how warm it is normally in a given month and country. And here we took for example, countries that have an average temperature in summer around 12 degrees, 21 degrees, 25 degrees. Now, the impacts are positive in countries and months that are already warmer on average.

So, for example, in summer. And we basically show here the response that we find empirically, and the response is shown in cumulative terms over a period of 12 months, which you can see on the X axis. I mean, you can still say, "Okay. This seems relatively moderate or modest in impact." I mean, what we've also done, we mainly concentrated here on food prices because or food inflation because that seemed to have had the biggest impact in the overall HICP measure. But this food inflation then also has an impact going forward on headline inflation.

Now, the interesting thing here is that we have now basically looked at a gradual increase by one percent, one-degree increase in mean temperature.

But the question is, if this basically gradual increase continues, we also have to look at the impacts of extreme weather events because there is simply a relationship between this gradual increase of temperatures and the occurrence of extreme weather events.

And what we did here is to look at the extreme summer heat in Europe last year. And there we know from basically looking backwards that in our estimates, the summer of 2022 heatwave increased food inflation in Europe by around 0.7 percentage points on average across countries in Europe. And science tells us that climate change will also imply that extreme weather events will occur more frequently and become stronger. And in fact, we have already seen heat and drought extremes increase.

For this type of research, we teamed up with researchers from the physical science side, and combined our empirical results with projections from state-of-the-art climate models that were also used by the IPCC. And this helps us to understand what will happen in future climates. As can be expected, we find that the warming projected for 2035 would imply the impacts of an extreme summer similar to the one in Europe in 2022 by around 50 percent.

So, in other words, what we've done, we've basically took, took, took what we think in terms of normal climate change, the gradual increase of temperature, and then added on top such an extreme weather event like the summer of 2022, and then basically looked at what does that mean for inflation? Now, I said, it is important to note that we interpret our results as an exogenous effect of global warming on inflation in the absence of technological changes that will help our economies adjust to a changing climate.

And in the context of this conference, this only makes it clearer that we really need climate change action at this point. Turning to my last slide in summary, I mean, going forward, our macroeconomy will be affected by both climate action and a changing climate. It will not be either/or. Both dimensions of climate change will be relevant for our macro economies. I want to stress three dimensions in which this is important for central bankers or maybe also economists in general.

First, in central banks work, for example, projections and assessments of the macroeconomy, we need to increasingly consider both the materializing impacts of climate change and of climate action on our economy. Second, when we discuss the macroeconomic impacts of net zero transition, this should be reflected against the baseline in which physical risks materialize.

And third, and very importantly, climate action and adapting our economies to changing climate will be beyond limiting all catastrophic consequences of

climate change that were to some extent also mentioned yesterday, also reduce the risk that a warming world poses to inflation, and to our economies in general. And this concludes my intervention. Thank you.

Jean Pisani-Ferry: Thank you very much, Christiane. And thank you for having reminded us -
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Philippe Aghion: I will ask the question afterwards.

Jean Pisani-Ferry: Yes. Okay. Thank you. Thank you for having reminded us that we should be looking at mitigation and the consequences of mitigation. But also, the counterfactual is not a world in which inflation is stable, and is not a world in which obviously climate is stable. And so, that's a strong reminder, and I think that's very welcome. Jennifer?

Jennifer Harris: [Inaudible 0:28:39]?

Jean Pisani-Ferry: Yeah, if you may.

Jennifer Harris: In some ways, that's a really nice point of departure, your point about really starting with the counterfactuals, and that's probably as much as I have a kind of bumper sticker for my intervention, it is that we really need to think about the counterfactual in all domains of how the clean energy transition plays out or not. And that's most true perhaps in the political domain. And I'll just speak to the US, which I know best.

The counterfactual of how a Republican-led White House would handle all of these things or not is really what I mean, and I think will be a through line that I'll weave through these remarks. I do have a couple of slides. You will quickly know that this is not -- whatever my strong suits are, this is not among them. We can --

Jean Pisani-Ferry: Well, did not on screen yet. Okay. Yeah.

Jennifer Harris: There they are. I'm sorry. My kids were sick last night, so they're even worse than they would be. But the point that I want to start with is essentially that as you've heard in stereo and I gather from yesterday as well, the price tags are quite high on insufficient action. And the modeling appears to be quite hard, leaving us with a good amount of humility, which you all know better than me, frankly. Just let you peruse some of these. I think Ms. McKinsey headline in particular, and I'll spare you the McKinsey slide deck behind it, but rest assured there's --

Jean Pisani-Ferry: You want to go to the podium?

Jennifer Harris:

That's okay. There's many slides that you can pull up from McKinsey bearing out all the ways in which indeed the whatever the 9.2 trillion or costs of actually adequately acting are, they pale in comparison of the cost of not adequately acting. And the second point is that we know that there because of extreme weather events among others will be place specific shocks that will probably be destabilizing, and have further knock on macroeconomic effects.

I just pulled out two here that you can see, and I have skepticism about whether the modeling here just to take the California wildfires is a somewhat biographic example. Our pricing and all that needs to be priced in having lived through the 2018 wildfires, and the 2017 ones before that while pregnant and with a newborn. I think the science on the intersection between public health and macroeconomic output is still pretty nascent.

But I do know more than I care to about the way in which particulate matter crosses the blood brain barrier, creates autism, all kinds of learning impairments. And I think you're going to see this play out on a wide scale would probably work force effects if left unchecked, just as one example of making sure that we are being as encompassing, and in the modeling of all of this as we need to be. And then to the budgetary impacts, just rounding this picture out. This, again, is just from the US.

This is from a blog post that the White House did earlier this year. You're looking at somewhere on the order of seven percent revenue loss into the US budget, and probably outlays of upwards of 128 billion a year dealing with just six types of federal expenditures. And then to the job picture, and the point here is really that we, again, should have low confidence in the modeling of a lot of this stuff. So, I start here with a stat from Deloitte in 2020 suggesting that if we do the clean transition correctly, we could be looking at somewhere in the order of a million more jobs.

And then, and the way that we obviously the Biden administration went about the Inflation Reduction Act, my guess, I put the BlueGreen Alliance UMass Amherst numbers here, not because I'm wedded or particularly fond of them, but I think it just shows you an upper bound of the ranges of job footprints that are being thrown around, and the actual doing of the thing once we have a face on legislation, and we do have a better sense of exactly how the climate power job figures were built, so I could stand behind those more credibly.

I don't know from the BlueGreen Alliance numbers one way or another, but this was just -- the last stat here is just in the first five months of the Inflation Reduction Act, and you're already seeing 100,000 green jobs announced, which makes me pretty optimistic that in the fullness of time we will well exceed Deloitte's projection that we're looking at a million jobs in the US

economy by 2070 if we do all of this right. And so, I think all of this cashes out into a pretty strong argument for action.

Jean, I think to quote you from a moment ago, “We need to act. We need to act without delay.” But I think what I can contribute to this conversation is the kind of pragmatism wrought of recent experience trying to do exactly that. And when you put all of this work into the political arena and you’re trying to do big things, you’re going to get stuff with hair on it. And I think we -- I would just urge us to figure out what the bounds of flexibility and forbearance are what the point to an earlier comment that we’re going to need several measures, not just one.

It’s not like there is a carbon price that will be the beginning and the end of this. I think the point is really the exercise needs to be having countries come to a common understanding of the indicia of what net constructive, unilateral national actions are. Whatever the answer to that question is, I think one portion of it is that you see positive global spillovers. And this just gives you one indication of the kinds of positive global spillovers we’re seeing from the IRA.

So, the blue and green tails on these gray bars are essentially bending cost curves of different clean energy technologies itemized across the X axis there downward. And so, the green bars are bending them downward for the US only. And then you see the global bars represented in blue or I guess darker green in the case of this one. And so, I think on average, you’re looking at this, is this is from the Boston Consulting Group bending average cost curves across the clean technology horizon down something on the order of 15 percent.

So, clean energy across the board just got 15 percent cheaper, and deployed that much faster thanks singularly to the US taxpayer, which I think is a fact a little bit lost or at least underappreciated in some of the political discourse on the kind of net benefits globally on the IRA, although it depends on it actually being successfully implemented and enacted, which is, I think no small question going forward. So, I think anyway, the point is there’s like a fruitful vein of conversation to be had around what the other indicia of net constructive national legislation looks like.

I would posit that one indicia is some amount of net positive spillovers, and I think that should be a characteristic of subsidies in general. Stepping back, I’m a pretty big fan of the move the Biden administration has made to rethink climate change, and move away from thinking of it as a market failure. Thus, the answer overwhelmingly being one of figuring out how to price it appropriately in the form of an explicit carbon tax or fee or legislation or regulation that that gives you an implicit fee, and instead shifting to conceive of it as a political problem and a technological problem.

Whereupon using public investment to crowd in private investment, and create good jobs that depoliticizes a lot of this becomes the obvious move. Now, it's true that it's easier, it's a little easier for the US to say this because of our ability to finance our own deficits and our ability to print our own currency. But it's not as if there's a way in which some of the discourse around the IRA makes it seem as if this was all just candy.

And I apologize. I was a few minutes late this morning coming in because I was doing a conversation with the editorial board of the Financial Times, and this question of like, who's going to pay for the candy, given that a lot of these tax credits are uncapped, actually came up. And so, I would remind us that there is a bill associated with the IRA, and the US taxpayers are on the hook for footing that. And so, there are costs that are being buried. And I think in some ways, the fact that you're running it through a relatively progressive tax system is the way to do it and spreading those pains.

And then final slide. Any guesses as to what this number represents?

Jean Pisani-Ferry: It's a range, but --

Jennifer Harris: This is just closing with a reminder here. This is actually the adjustment that happened in the Trump administration to the social cost of carbon when they elided whatever mathematical gymnastics they went about, they reduced the social cost of carbon to an estimated one to seven dollars a ton. And I like to go back to this number as a very pressing, urgent reminder of the need to lead with the politics, and make sure that we're getting the politics of the clean energy transition. Right.

Certainly, in the US, in order to make this as sticky and as durable as possible, and that means that we're just not in the world of first best, most efficient ways of developing answers to these things. And in some ways, I like to fight this question of are things like carbon border adjustment mechanisms or the domestic content provisions, the orders that are on portions of the IRA, the most efficient way of going about all of this.

I actually think the answer is yes, because when tested in any real world scenario of how long it would take, I see no viable path for an explicit carbon fee in the US. It hasn't happened in my lifetime, and things are getting worse, not better on that front. So, I would posit that actually this could well be the most efficient of any of the plausible alternatives and the stickiest, to be sure. So, I will leave you with that. Thank you.

Jean Pisani-Ferry: Thank you. And so, do you go back to several points you addressed. But before that, I would like to give the floor to Bea.

Beatrice Weder di Mauro: Thank you very much, Jean, Adam, for having me here. It has been an absolutely fascinating first day, and a lot of interesting papers that I still will -- I already know, I will assign to my students most of them. So, my job, as I understood, was to give my interpretation of what is the takeaways in terms of what do we know by now on the macroeconomics of climate change and climate action.

And so, I want to start where we all need to start is what do we understand by now on the impact of CO₂, mostly CO₂. There are other greenhouse gases on average temperatures, and this is fortunately by now quite well understood. This chart you have seen if you were here for Jean's presentation yesterday. This is from the IPCC. The historical temperature range and the cumulative CO₂ emissions. And rolling this forward, we have a quite good understanding of where we are going under different scenarios of how much we are still emitting and accumulating further CO₂.

The good news here from this IPCC is that this is a little bit flatter in terms of the more extreme accumulation parts are no longer seen as the most important ones. And nevertheless, if we take this now, and we see also there is a bit of uncertainty. I do actually read this as a relatively small amount of uncertainty, given that sometimes people go like, "We don't know anything." We know quite a lot.

The amount of uncertainty of what is the human caused range of the accumulated CO₂ in the air is rather small. But now let's cut this the other way, and that's the table I did want to start on because it seems to me it's the most important table in the world. It's really the way to understand what this means in the previous chart, now cutting this chart across different temperatures, and looking at what this means, and how much is left for us to spend. This is the carbon budget, right?

The carbon budget, so we've used up 2400 gigatons. And I really want to encourage everybody to think in tons. Once we start understanding what tons of CO₂ mean, and what are the dimensions, it makes the conversation so much easier. So, this is all about the gigatons, 2,400 gigatons of have been used up or have been accumulated. And that means then the chart is red or the table is red the following way. If we want to stick to the target of 1.5 of Paris, then we have about half a degree left to go because one degree is already in the bag.

And that then translates into here is where you see the uncertainty, the translate into different probabilities of reaching this 1.5-degree target. So, if we go for high certainty, which usually, in our statistics, we want 99 percent, so let's just go for 80 percent, 80 percent certainty of staying below 1.5 would mean there are 300 gigatons left. Now, this is already two years ago. So, we should actually take away about 80 because we are using about 80

per year, and the emissions have not per year is 42 years gone. So, 80, 35 tons are from fossil fuel, and 40 or five additional from land use change.

And so, if that is the number, 300 minus something in order to be at 80 percent certainty or if we want to be more generous and say, “Well, 50 percent is good enough for 1.5,” then we have 500 gigatons. In fact, I tend to use the 500 gigatons, which also seems to be the one that you use most Jean. Why is this table so important? Because it shows that’s it. It is irreversible. It’s a cumulative process. If we do more than 500, then we have a higher outcome, and it’s going to stay for the next 100 years, if not thousands.

And that is the background against which once I think this sinks down, it is no longer a question of marginals. It really becomes a question of what are the risks that we need to avoid today in order not to burden the really distant future, not only our children, grandchildren, but the ones that are going to be living in the next hundreds of years. So, this is the carbon budget now, these 500 gigatons, and I’m going to come back to that, that we have left. And we have a way to think about how we are going to be using them.

Now, the second question is what is the output impact of no mitigation? And here the estimates are rather large. So, one of the biggest estimates is from Burke and Co. But even here in this, it’s not happening in the next few years. It’s not happening, in fact, in our lifetime. It’s beyond it. By 2100, it starts becoming really large. So, one way of looking at this is to say, “Well, the future is the problem, not us right now.”

Similarly here, if you go far out, you can get very large output declines up to 25 percent of GDP from the more extreme scenarios of going over, and having temperature increases in the area of four to five degrees. But the variation of the different studies is also quite large. So, here this is still on all about the for the counterfactual, we were talking about before. What are the variation? Well, there are very large output effects, but there are also studies that have rather small ones even for the long run. And that is, of course, what makes things not so easy to argue.

But the bulk of the studies seems to focus on somewhere like five to 10 percent of GDP output decline over the long run in the case of insufficient action, let me put it this way. But now come also already here, there are quite these averages for the globe. I think I would start arguing as I will continue arguing is not really the interesting point. It’s quite different whether you are already a hot country, so geography matters or whether you are not.

So, the slopes of what temperature increase does to your GDP per capita loss is quite different whether you are red or whether you are blue. So,

where you are sitting now matters for how large the GDP impacts are of no action or insufficient action. Here is the study for the European Union. This peseta that Jean was also quoting yesterday. And when you read here, the main takeaways, the tundra essentially disappears. Europe in the south becomes almost tropical, and 300 million citizens in the EU and UK would be exposed to heatwaves. Well, that sounds pretty big.

But then comes the conclusion this is a welfare loss of today's economy without adjusting of 1.4 to maximum two percent of GDP. And then you go like, "Wow," that's not so much again, right? So, that's where a lot of confusion comes from. So, the models are not here. This very good study, which comes from bottom up, does not imply a huge welfare loss. So, maybe what is more important is how it is distributed across the European continent in this case because in the south it is much larger, and I'm not including the mortality here because that is actually the biggest piece.

So, I'm just using the other natural consequences of different degrees of climate change. And you notice that in the Northern Europe there is also some benefits. So, the distribution, geography matters. The distribution is important. Now, back to averages output impact of mitigation. And that is, I think most of the papers that we have seen really most of them suggest the impact of mitigation is smallish. And so, I'm using here the study done for the year in October 2020. This is a McKibben Wilcox with GQ. So, they simulate different individual types of mitigation policies, and then combine them into a package.

And the conclusion, again, is it's not very big. In fact, the pattern there is that you get a bit of a growth boost at the beginning, and then there are output costs. But let me emphasize again, there are distributional issues here. It's not the same across countries. It's not the same across regions from this same model that I was showing before, you see that two areas are actually quite affected. One is Russia, and the other one is oil producing countries. So, are we assuming that they are also in the boat with these kinds of packages? Probably not.

So, actually in their study, they were co-benefits, which mostly occur to these countries that I didn't quite understand why. Then somehow it levels out. But again, emphasizing here differences across the world. Price impact and inflation impact of mitigation, I mean, I studied these things myself. This is from our paper on inflation and past carbon taxes in Europe and Canada. Bottom line, yes, there is a relative price impact, so it works. Carbon taxes work, but the overall inflation impact on headline is on headline inflation mostly, not on core, and core not on headline.

So, overall, the inflation impact, and this is my co-author who went on, and with Ken Hensick to do the same thing. Carbon taxes and combining the

ETS system, the shocks to inflation, and our smallish and transitory nothing that central banks couldn't deal with. I'm not saying central banks don't have to worry about it. Yes, they have to model it, but they can absolutely deal with it. And this is another simulation with Warwick McKibbin. This time, we did a European version of his G-cubed, and tested different types of monetary policy adjustments.

You see, you can get inflation or deflation in response to a carbon mitigation. This is a carbon tax depending on how the central bank, how the central bank reacts. But in all of these cases, my conclusion would be not our prime worry. Okay. In the near term, a lot depends on how you model. This is the year from now on how you model the mitigation. So, different carbon prices across the world and across regions. Notice biggest impact is, so even though the rest of the world doesn't need the biggest carbon tax, it still has the biggest output impact, and under certain conditions also the biggest inflation impact. But this is still muted.

So, I'm going quickly through this because I want to get to my last two points. This one here is what Jennifer was just discussing. So, transition cost mitigation plus adaptation, well, where are they? I'm saying here looking across different, different studies, 1-3 percent of global GDP. This is a huge contrast with what the McKinsey study that adds up to 275 trillion. But of course, there's lots of double counting in McKinsey in the sense that not much is actually additional there. It's out of 9 trillion that they have on investment in transition three would be additional. So, we're talking more like three percent of GDP of additional.

And by the way, a lot of it could also be by privates. So, now I'm getting to the point, the distributional implications across the world, and geography matters. Most of the impact of climate change is going to be in the countries that are dark here, so mostly in the tropics. And on the other hand, here is what the distribution of the emissions today looks like. You see that in the tropics there is relatively little that is being emitted and contributed to today's emissions.

And now what I've done is the following. I took the total carbon budget of 500 gigatons being a bit generous here, and distributed it across the different countries, and regions of the world according to what would be the implied carbon budget per capita from sticking to net zero. So, you remember the volcano chart yesterday from Turkey? Well, that's what I'm doing here. Implicitly, I'm giving Turkey, and each Turk the share of the remaining carbon budget, which is a function of how much they are emitting today as a part of the total emissions, because that's what net zero means.

So, those who are emitting a lot need to go down a lot, but they also get a lot on the way there. And so, now doing this per capita. So, Jean yesterday

talked about the EU being fine. So, the EU about with the fit for 55 has actually an embedded a carbon budget per capita of about 70. According to this calculation, it could actually even be 88. But that's it for every single one of you, 88 Europeans, that's all you get. You start calculating how much you can fly.

And for the world, if we distribute it equally across the world, it would be about 60. Every single person gets about 60. And it doesn't matter if we use that up by 2050 or by 2060, it doesn't matter because it is cumulative. It's how much there is left. Now, you notice that there are some inequities in this, right? So, implied in our present net zero strategies, and NDCs is that a Chinese gets much more, and a Russian actually gets much more as a total carbon budget. And Africa -- this is just an estimate, rough estimate I did in Africa for people outside South Africa gets about 10, a budget of 10 tons forever.

So, you see, this is not feasible, right? So, either we get a carbon -- what we -- many things you can do with this, you can say, "Well, let's have a carbon market." So, we give 60 to everybody, and then let's trade. And that would be, of course, one solution. But we notice that this is climate inequity, forward looking. I'm not talking about what has happened in the past. This is the forward looking under the assumption that we actually stay within the carbon budget. Somebody will be able to use this up, and who is it? So, I submit that this is the biggest question we should be thinking about. Thank you.

Jean Pisani-Ferry:

Thank you, Beatrice. We have about half an hour for the general debate. Before that, let me go back to sort of the core issue where we're discussing. You repeated that consequences of climate change mitigation for output, and inflation are bound to be smallish, so insignificant. This is based on model simulations. And where I'm not comfortable with this result in that it's not explicit enough about the underlying mechanisms by which, I mean, how much of your -- let me distinguish between output and inflation.

On output, it goes back to the discussion we had about productivity, and the fact that we need to discuss whether there is a diversion effect away from the kind of technical progress we used to towards a new type of technical progress, which is to save on fossil fuels, but which is bound to have an output cost. On inflation, and here perhaps I'm going to ask especially Christiane, Isabel Schnabel is on record saying that the climate transition at least for the next 10 years is going to mark the end of the Great Moderation.

There is going to be a period of great volatility because the transition is, just by nature, bumpy, because you have to change your energy system. You have the problems of mismatch between the green and brown investments. You're probably not investing enough in general at global level because you

have all the scarcity of the materials that are crucial for this green economy. So, we can be very optimistic about the medium in the long run, but the next decade is likely to be to be bumpier. So, that's the kind of question I would wish you to react to.

Christiane Nickel: No, indeed. I would also say that that -- and we heard that already yesterday, given the uncertainties that we have not so much on the forecast of how the weather will change, but on how climate change action will go about what it will mean in terms of also the adjustment of the economy. Indeed, there is the risk of these bumps, and also that there might be policy mistakes, given that this is an unprecedented transition that we have to go through.

So, this transformation that lies ahead of us is something very unique. There is no precedent for that. And therefore, there is also some risk, let's say, of policy mistake. Coming back to the issue of, yes, the inflationary impact, and there I would agree, and this is also the finding of our paper is on average, if we have this gradual increase in temperatures relatively manageable.

But what of course is happening with this, let's say, increase of a gradual increase in temperature is that simply by scientific evidence we know that this also will bring extreme weather events. This will bring flooding, this will bring droughts, and these extremes they can amplify then also the effect of inflation. Now, the issue is for us in terms of modeling and so on, we have, let's say, little problems in putting in gradual increases in these weather events, et cetera.

But when it comes to extremes, and these bumps that you mentioned, then there is a problem also in terms of modeling. And then we are sort of this is why also when we look at the error ranges around our estimates, they are rather wide. And so, you cannot exclude that even though, let's say in this gradual changing world or structural change that, yes, everything runs relatively smoothly. But if there are these extremes, these bumps, we will have an impact.

Jean Pisani-Ferry: Thank you. Any other reaction? From the panel.

Beatrice Weder di Mauro: I can only agree. This I mean higher volatility not only in terms of prices, for all the reasons that we have also discussed. There can be bottlenecks, but there is also I mean already with one degree warming, and it's going to be more even in the best case, more extremes, and more shocks are going to happen. And that's going to mean more volatility for output and prices. I think that's a that is clear.

Jean Pisani-Ferry: Jennifer?

Jennifer Harris:

Yeah. I would just want to inject a note of uncharacteristic optimism on the importance of policy choices, and the design of how all of this hangs together, a couple of different examples to put some color on it. I think we're already seeing a warranted unwillingness on the part of oil and gas majors to put a lot of capital expenditure in new infrastructure, and that's that needs to happen as part of how all of this goes. So, I think to be welcomed, but that's doing a lot of the work, I think behind a lot of the volatility in traditional energy sources in this transition.

There are known government interventions that can be brought out. And I think we can push lean in harder on some of those, free public transit. When you see gas prices rise to a certain -- above a certain level, that's not going to be a panacea, certainly in the US. Do I think much better go further in places like Europe where you have a more responsible public transit system? But it's material. I think you're seeing a price volatility in things like critical minerals on the other side of the transition.

And likewise, we have like time tested playbooks about how to deal with price drop in essential commodities going back to Roman agriculture. Spoiler, it looks a whole lot like price insurance that we should be thinking about more aggressively, and more quickly than we are looking just at lithium. Over the past couple of years, you've seen lithium prices spike about 800 percent. They've softened a fair bit. And we talked to mining majors about why they're not investing at the clip needed, given clear demand signals that are flashing in neon.

This is a version of what they say. They basically say we have PTSD from the commodity downturns of 2014, and our shareholders are making money again, thank you very much. And we're pretty sure that China will figure out a way of dumping on the market, even though they themselves are a net exporter. We don't know how yet. But if past is precedent that will be there. And I think there's a clear role for forms of public insurance that can make all of this go better.

The last example in the US looking at the political economy of utilities, right, gas utilities have a mandate to serve everybody. And so, if you see homes electrify on the home retrofits that are part of the IRA anywhere near according to plan, you're going to take away a lot of those middle and upper-income ratepayers that are currently subsidizing a lot of the lower income gas customers in the US, and that's going to make gas bills rise for the people who can afford it least. And there are easy ways to get ahead of that by figuring out how to go in first, and get some of those communities off of gas.

Likewise, I think keeping utilities together combined electric power utilities and gas help the political economy of those entities in this because they can

basically just green their asset base as gas becomes less feasible as long as they're cleaning up the grid, and the way that they already are, they should be able to recoup a lot of those losses. And that will make them a more constructive player in how all of this goes. I'll leave it there.

Jean Pisani-Ferry: Thank you. I see Phillippe Aghion, and Robert Lawrence, and Suman Bery.

Philippe Aghion: The question I had, I mean, if it's true that global warming will raise inflation risk, and the risk of price instability, so that might have impact on the way to conduct monetary policy. For example, we used to say, "Rising interest rate is a way to fight inflation." We know it's one of the ways. But now we have to factor in the fact that if we increase interest rate too much, that might make, discourage green investments.

We know that I'm doing some current work. In fact, with Martin De [inaudible 1:08:23], and other colleagues at LSC, Jean van Reenen, where we showed that how to finance, tighter finance particularly makes it harder for small firms to innovate green. So, you have to factor that in now in your way to conduct, because it could be that if I raise interest rates too much, I delay those investments. So, I prolong global warming, and therefore I get more price instability and inflation.

So, it'll be interesting to see how you factor. Similarly on debt, we know that yesterday we argued in the work with Darren and David, and if you delay action, you increase the cost of -- so, for example, you could say well to reduce my current public debt in France for example has high public debt because of that to follow Maastricht, the Maastricht Treaty to the letter, I might want to delay certain kind of investment to remain within the three percent or whatever.

But if by doing that, I increase the cost of transmission tomorrow, that's not good because there is a monetary debt, but there is the environmental debt. And now you have to look at both together, and there is rising demand for not counting green investment the same way as you count, recurrent spending or other things. So, how do we deal with that? And the third thing is that something we did not mention is plan B, the I know that we look strange in this.

I mean, there is research in Harvard, but in other places for ways to cool down the atmosphere, actually. And it will be very interesting to say what happens if we factor in Plan B. And of course, we don't want plan B to discourage plan A. And the question is, is plan B something we should just don't ask, don't tell, don't mention it because it would derail any plan A action, or do we believe there could be some complementarity between some Plan B and some plan A?

But we cannot do as if plan B doesn't exist because there is research actively going on for cooling down the atmosphere. And so, it would be very interesting to see when you factor in Plan B, you had in your scenarios your most pessimistic scenario, your more optimistic scenario is maybe too pessimistic because maybe there is this research that we can also have. Those were my questions. Thank you.

Jean Pisani-Ferry: Okay. Robert. Let's go to Robert, Suman, and then back to the panel.

Robert Z Lawrence: I think this was a gap in our discussion yesterday already when the modeling was done on climate change action, they were putting a price on carbon, and it was raising a lot of money for the FisC as a consequence. But if we actually look at the Inflation Reduction Act, what that's doing is draining a whole lot of money from the FisC. And if you look at the estimates, basically no one has the foggiest idea about how much that's really going to cost.

The Congressional Budget Office estimates, were on the order of I guess I think it was 270. Is that the number? It's on top of all of this, but by the time Credit Suisse was finished, it was, I think, closer to 800 billion. And by the time Goldman Sachs was finished calculating this, it was 1.2 or 1.3 trillion dollars. So, actually, it isn't really an inflation reduction act of Goldman Sachs is correct. It's an inflation resuscitation act because it's really uncapped subsidies which have been provided.

So, it does seem to me that if we were to think of it in those terms, in terms of what's happened in the United States, and I don't see much hope, and I would agree in terms of the politics, that the United States now suddenly imposes a tax after having committed itself for 10 years at least of these subsidies. We have no control over those subsidies. And so, I actually think there is an inflationary, a traditional inflationary problem of fiscal coming through fiscal policy, which hasn't been in this discussion so far, and imposing discipline on the FisC in a sense is an important, in my view, a priority.

And I don't think the recent dispute over the debt limit, which was all focused on government spending actually covers government tax breaks. That's something the Republicans don't seem to be worried about. So, I think the United States is in danger of a significant lack of discipline, and therefore, the inflationary pressures in the intermediate run could be much larger than we're talking about.

Jean Pisani-Ferry: Yeah. Okay. Yeah, go ahead.

Beatrice Weder di Mauro: Yeah. Sorry. Was that me or --?

Jean Pisani-Ferry: You.

Suman Bery: Yeah. Okay. Fine. This is to Beatrice, but perhaps Joe, you want to come in as well. So, I was a little unclear what this chart about, as it were, the allocation of carbon by nation reflected. I assumed it was the indices, and that's what's implicit there. But my question was how to link this with my take away of what Jean had to say yesterday, which is that speeding up the adjustment in, say, the EU would be inefficient. Okay. So, Jean, either you, Beatrice or Jean might want to connect these two. So, is there an inefficiency in going to a more equitable distribution of the remaining carbon budget? I'm a little lost.

Jean Pisani-Ferry: Okay. So, who wants to start? Perhaps Christiane, because there was a question directed at you.

Christiane Nickel: Yeah. On this question of, I mean, of inflation and monetary policy, and what would that mean for our policymaking? I mean, one thing is indeed, first of all, what I presented here was that that we take this phenomenon of climate change, climate action now seriously, and try to embed it in our models, just like we would do it with other structural changes that we see in the economy. And when you talk about the impact that that would have on monetary policy.

So, when we look then at the modeling, we would not just look at the impact of climate change, but also of other structural changes that are going on in the economy, be it demographics, be it digitalization, be it de-globalization now, et cetera. Now, and in such a world where you basically have to look at all these different factors that are going on, including then also the conjunctural factors and so on. I mean, it's very hard basically to say what is then the impact overall on monetary policy.

I mean, if you say it's simply an *ceteris paribus* world, then, and we see that this is indeed having a positive impact on inflation, then this is, of course, has an impact also on our policymaking because we would raise rates or whatever simply because we are not adhering to our monetary policy target that we have now in terms of discouraging, then at the same time, investment, I think that that is a fair point. And this is also why I think it's important to have this integrated into the models to exactly have this kind of connection. Also, basically in there in the back of our mind. Nevertheless, I mean, at the end of the day, we have a price stability objective.

So, that is our primary objective. And this is what we have to adhere to. I mean, also to just say sometimes we say, "This inflationary impact is very small." I mean, you heard just that until a year ago, I was head of the Prices and Costs Division. We have a very much -- I mean, whenever we have a forecast error of 0.1 percentage point, we already have a problem. I mean,

or 0.2 percentage points. I mean, we are tracing back, where is it coming from? And therefore, not to look at climate change, even if the impact is small, could imply a policy mistake possibly.

And then you ask this question, and I thought that is interesting is this question of the delayed action, and that this brings more costs. And indeed when we look at the fiscal sustainability in Europe, I mean, we see that a lot of countries have actually little fiscal space. And then when you look at my map that I showed that you see, for example, Italy is one of the countries that might be impacted most from climate change. You realize there is an overlap here between, on the one hand, a country here with already existing fiscal sustainability issues or high public debt, and at the same time also these large investment needs.

The thing is, we are at the moment discussing this whole this economic governance review. That is something where we would like to bring in also this aspect that that investment should be shielded, and that we are not seeing with, let's say, stronger rules in effect that actually investment is cut down, which we have seen basically in previous crises. But this is still, let's say, in the making. But let's just to say that this is something that that we are aware of and on -- yeah.

Jean Pisani-Ferry: Time is short. Can I give the floor to Jennifer to answer the question by Robert?

Jennifer Harris: Sure. This was on the inflationary pressures of the IRA?

Jean Pisani-Ferry: Yeah.

Jennifer Harris: Yeah. I think it really comes down to whether you find supply side progressivism, whatever you think best articulated by Secretary Yellen, credible or not really. I think the place to start is before this bout of current inflation. And when you look at the primary preoccupations of most macroeconomists following the US, 2016 to 2020 was all secular stagnation, right. And then it became the first two years of the Biden administration, all about inflation.

And I think my view, I would associate myself with Secretary Yellen and several in the White House is that like whichever of those worries keeps you more up at night. The answer is the same, which is to push out the productive potential, the genuine productive potential of the country through a set of backbone infrastructure investments. That's not just about the IRA, right? It's about chips and science. It's about the Bipartisan Infrastructure Law. And that that will create genuine sources of productive capacity and supply that can push back on the inflationary pressures that we have seen, 0.1, 0.2.

I think that a lot of these new jobs that are being created will be taxpayers, and we will see, some relief off of the kind of needs for a lot of, social services that, often are not as factored in as I would like them to be in some of the CBO estimates, which is a way of saying if Republicans are fond of dynamic scoring for tax purposes, I'm a fan of dynamic scoring for the GDP boom, and the ways in which that will contribute longer term back into the fiscal purse.

But I do think where this gets really quite real is around the need for genuine, no kidding workforce development, and quite fast when you look at the what we're doing right now, we've never tried to do, which is build entire supply chains at a time that are multi-step and vertical integration. And that's just going to put a lot of stresses on the workforce. And I think we as probably as a society is acutely certainly in the US, have just never been foot forward on worker training, and that will be one of the biggest sources of inflation in the near term.

Jean Pisani-Ferry: Thank you, Bea. Perhaps a question by Suman on the efficiency dimension of the carbon.

Beatrice Weder di Mauro: I can also say something about the plan B of Philippe. If you don't mind. I mean --

Jean Pisani-Ferry: Very short.

Beatrice Weder di Mauro: Very short. I mean, the risks are just very high geoengineering. We understand that Pinatubo can put sulfur oxide into the air, and that you can somehow cool the planet temporarily with that. But we don't know what the risks are in terms of what it means to weather patterns, and whether the monsoon, and there were lots of things that happened during Pinatubo that that were not necessarily positive. So, second, yes, the question, so what I did is very simple. Let me take the numbers for India.

So, right now, so assuming we have 500 gigatons left as a world carbon budget, and assuming that through NDCs or whatever mechanism, everybody goes to net zero. And also, I'm assuming that there isn't much carbon extraction. So, we can add a little bit if we think that direct air carbon capture is going to be really big. So, basically just ask the question how are these 500 gigatons allocated in today's framework, and the way that we are thinking? So, the US right now has a what -- how much is the -- so, China right now is about 1.11 gigatons.

So, it has to somehow get down from 11 gigatons. And then what I said is, "Okay. These are the per year." So that China is -- the share of China of all total emissions in per year is about 30 percent. So, I give 30 percent of the

remaining carbon budget to China and divide that by the population. So, that's all I did, right? So, you can divide the total carbon budget by everybody, then you get about 60 to 70, and everybody gets the same.

And then we see how we trade or what do we do. But if I do what we have essentially agreed, everybody goes to net zero from where they happen to be right now, then those who are emitting a lot right now get more. That's the simple, the simple mechanism here. So, for India, which is now emitting two tons per year, it gets five percent of the remaining total carbon budget, and that's per person about 20 tons per person. So, that's all I did in order to illustrate how unequal really we are thinking about the transition.

Jean Pisani-Ferry: Yeah, please.

Christiane Nickel: Sorry, I should have mentioned, I think the most important point to place to start in your question is this point of a counterfactual. So, one of my slides I laid out the projected budgetary impacts of insufficient solutions on climate out to 2050. OMB ran these numbers. They put them out about a month ago, and they basically find that you're looking at two trillion dollars a year in less revenue coming into the US public purse. And so, it's like we can pay two trillion dollars now, all in which is roughly, Goldman Sachs estimate of the IRA. Or we can pay two trillion dollars a year every year if we don't do anything.

Jean Pisani-Ferry: Thank you. Let me go back to the list of questions. I have many. We have five minutes. In principle, let's say we take 10, but questions should be extremely short. So, I have this question here. Yeah. Jean. No. Yeah. No. I'm just growing up my list. Go ahead.

Michael Grubb: Michael Grubb from UCL professor, Climate Change in London. The session is about the macroeconomics of rapid transition effectively. And one thing is I think we're going to need a much better understanding of the relationship of finance, and the electricity sector. You look at the scenarios, you're investing more than one trillion dollars a year globally, and the great majority of that is in the power sector. It's pretty much a trebling of the investment rate. The electricity sector is central for many reasons, but one feature that's really not been figured at all is its nature, and relationship to fossil fuels.

When you look at the crisis that hit last year, people focused directly on gas. More than half of it now is electricity, and it is a highly volatile market because it's basically driven at the margin, marginal cost pricing by the fossil fuels required to keep the lights on. That cost went up to the roof. Government subsidized hugely close to a 800 billion dollars. And yet as renewables come in more strongly, you'll have more periods when the price crashes to zero or even negative. So, the volatility of the electricity sector,

I think, is going to be an absolutely fundamental thing to understand in this transition, and how to manage it. I just wondered if any of the models. Thank you.

Jean Pisani-Ferry: John.

John Hassler: First on Christiane. So, of course, what you should be worried about is extreme events. But we also know to the best of our knowledge, the frequency of extreme events like heatwaves is linear in the global mean temperature. So, it's going to be a smooth increase in that frequency. Of course, you should take notice of that. But it seems to be hard to come around the conclusion that even though we should be worried about climate change, the worry should not be that you will be unable to control inflation because of climate change, at least in the coming decades.

I would like to comment also on Jean's initial point on the prices. And you said that there is a big range in what prices are required. I showed that going from a situation where lots of fossil fuel is subsidized to a situation where we have a 20 dollars price on a mission that's going to make a big difference. I did not say that that's sufficient to reach, for example, the Paris target. So, there if we want to do that, I think we probably agree that we would need a price on carbon in the order of maybe what we see in Europe now, like 100 dollars per ton.

But I think we agree, lots of us, that that's not going to have a large cost. I do think it's going to be a cost. We are last year or two years ago, we had a paper in JP where we actually estimated on US data the consequences of price increases on fossil fuels leading to more technical change there where the cost is that you divert R&D from increasing labor and capital productivity. And we find that, but it's not a very steep trade off. So, I think the costs are likely to be small. And the policy implications of verifying that I think are very large. I think there is where we should focus.

Jean Pisani-Ferry: Thank you for the clarification. Last question is Pierre.

Pierre Wunsch: Sorry, it's actually more of a comment, two comments on monetary policy. I think the big unknown and the most important parameter is R^* more than inflation. I mean, are real interest rates going to go up because we invest more? And if so, well, in theory we don't even control our stock. On the cost of the transition, when you measure the cost, you have a big issue about what's the reference, is your reference a time when gas prices were at 50 or 20.

The oil price is 140 dollar per barrel or 80. And of course, it makes a big difference. So, what I try to show in my presentation is that compared to episodes when we had high energy cost, probably the cost of the transition

is going to be relatively small, but it's still going to be more expensive than gas at 20 euros and call it 15. And when you have technologies that have a positive payback like some renewables now that are competitive so that you would save compared to some brown technologies, at least for some green ones that do you compensate for the negative in computing the cost?

Or you say that would have been invested anyway even without a climate objective because the technology is cheaper. So, I mean, there are many discussions on how you compute the cost. What's the reference?

Jean Pisani-Ferry: Thank you. Can I get back to the panel? Perhaps starting with Bea, and then with Jennifer. Pickup whichever question you feel appropriate, perhaps R star.

Beatrice Weder di Mauro: Well, I think I cannot disagree with her. I see those also as comments. I think the very valid point that you were making about the estimates of carbon taxes being what quite the range is quite large. But there seems to be a consensus that in order to be sufficient, we are probably talking more about 200 or more in terms of CO2 per ton. So, in Europe we are now at around 100, and there is a there is a good possibility that it's going further up.

We also all probably agree that the chances that the rest of the world implements carbon taxes of that size is rather small. And in fact, in the in the study that I flew over with, that the IMF did now for this view, they suggest that the necessary carbon taxes are actually different by region depending on the elasticities on how easily, and elastically emissions respond, and they can mitigate.

But you still we're talking about carbon taxes that are way above anything that is very likely to happen in the near future. So, that's in my -- I mean, if I have to go back to that, that's why we have the two or more instruments discussion. It's not necessarily because we don't understand what the first best is. And I do also think that Europe is the closest by far to the first best, but the rest of the world is not going to follow. And Europe only has eight percent of the total emissions. So, we need to have solutions for the rest.

Jean Pisani-Ferry: Thank you, Christiane.

Christiane Nickel: Yes. Just to say that I agree with these comments that that were made both on this controlling inflation aspect, and also the impact that on our square that we have us are that we have to look at. I wanted to just add something to what Beatrice said, because that really resonated with me. These distributional effects that we have across the world, that we have also within Europe, and that we have within countries.

And I also think to think about the social impact that namely poor households most likely are more hit by climate change than richer households. And that we have to also think about the distributional effects of climate change and climate action. Also, in terms of regions, I think is something that we have to bear in mind when we design also climate action.

Jean Pisani-Ferry: Thank you. Jennifer.

Jennifer Harris: Sure. And maybe connecting Beatrice's last point that Europe has designed the as close as anyone has come to a first best solution, and the rest of the world will not follow with -- I'm sorry, I don't know the gentleman's name making the point about 20 dollars a ton global fee being woefully insufficient. Both seem very manifestly correct to me. And the question is, what then should we do? I think that argues for, and focusing.

If the point is to try to -- not just evangelize a European ETS because it will run headfirst into political walls, not just in the US but globally, but to build something that is load bearing multilaterally, I think you have to focus on the ends rather than the means, which is to say an ETS has worked pretty well for Europe. That's great for Europe. But if we can figure out a way of measuring what matters, which is at the end of the day emissions reduction, and not care as much about the means that every country takes to get to those ends. I think that's a much sturdier multilateral foundation from which to build.

And I think one co benefit of that is that at least when you look at where this might head in the US, I would look to the bill that has bipartisan momentum behind it for a US carbon border adjustment mechanism. One benefit is that you can actually set the price at roughly what we're talking about carbon costing, whether it's 150 or 185 from the nature study. And then you don't have to push that rock up a very steep political hill of figuring out ways to get it from 20 or even 100 to where we actually need to see it.

And the rejoinder seems to be, well, if the US goes this route, then what's to stop everyone else from doing it too? I think the answer is they should. And this is a way of cleaning up one another's dirtiest actors while still creating a mechanism for yourself to ratchet down the level of emissions that would catch a producer in its crosshairs over time. So, I'll leave it at that. Both good points.

Jean Pisani-Ferry: Thank you. I'm sure the discussion will continue, especially with the next session, and apologies for all those who could not ask their question have been a lousy chairperson.