CENTRE FOR ECONOMIC POLICY RESEARCH

CEPR CLIMATE CHANGE

Fourth CEPR/EAERE Webinar on Climate Policy: Carbon Pricing

30 September 2021 – 17:00 – 18h30 (Frankfurt/Paris/Amsterdam) – Online

Carbon pricing is useful to induce all greenhouse gas (GHG) emitters to internalize the climate damages associated to their emissions. But even in countries without a market pricing mechanism, it is important to value carbon in order to compare costs and benefits of the myriad of climate policies that will have to be implemented to attain their emission target. During this webinar, three panellists will summarize their findings about what carbon price/value should be recommended, or about the rate at which this carbon value should grow over time. The panellists will also identify the sources of uncertainty and of scientific disagreement surrounding this economic approach to fighting climate change.

For this Fourth CEPR/EAERE Webinar on Climate Policy, Maureen Cropper (University of Maryland & Resources for the Future) gave a presentation on *Improving the social cost of carbon,* Michael Greenstone (University of Chicago, CEPR & Climate Change RPN Member) on *The Global Energy Challenge and Pollution Pricing* and Christian Gollier (Toulouse School of Economics, EAERE CEPR & Climate Change RPN Leader) on *The cost-efficiency puzzle carbon pricing puzzle.* Their presentations were followed by a discussion moderated by Rick van der Ploeg (University of Oxford, CEPR & Climate Change RPN Member) and a Q&A session with the audience.

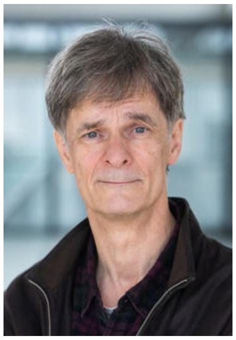
Panellists:

Moderator:

Maureen Cropper
(University of Maryland & *Ressources* for the Future)

Michael Greenstone
(Milton Friedman, University of Chicago, CEPR & Climate Change RPN Member)

Christian Gollier
(Toulouse School of Economics, EAERE, CEPR & Climate Change RPN Leader)



Rick van der Ploeg
(University of Oxford, CEPR & Climate Change RPN Member)

Key Points of the Webinar

- **Improving the Social Costs of Carbon (SCC)**

  - **SCC definition and calculation**

When calculating the SCC – that is the discounted value of the flow of marginal damages induced from the emissions of a ton of CO_2 into the atmosphere today - four important steps must be considered: 1. A projection of the carbon emissions path is generated using future population and GDP estimations (*socioeconomic module*). 2. Then, the impact of this CO_2 projection on climate (*e.g.,* mean temperature changes, sea level rise, *etc.*) is calculated (*climate module*). 3. The damages induced by these changes are monetised and aggregated (*damages module*). 4. Finally, to take into consideration that damages are persisting over many decades, a discount is used to sum them into a single present value (*discounting module*).

The SCC calculation methodology, used by the US Interagency Working Group (IWG), is based on a combination of the results of the DICE, FUND and PAGE Integrated Assessment models (IAMs). It consists in imposing on these models different equally weighted socio-economic scenarios and a common distribution over climate sensitivity. The uncertainty in damages and other parameters is preserved in FUND and PAGE. Finally, multiple Monte Carlo runs are run for each model using different discount rates. At a 3% rate, the value of the SC was for instance estimated at $51 a ton in 2020.

When calculating SCC, unlike with setting a temperature target, one is forced to make explicit judgements about damages and the value of avoiding them, as about the associated uncertainties. Furthermore, calculating damages makes the impacts of temperature targets concrete, thus providing support for mitigation measures and estimations of the benefits of adaptation. SCC methodology, however, raises various questions related to the different calculation steps and models used.

  - **Recommendations for improved SCC measurement**

One important recommendation is to break down the already composed IAMs and develop each unbundled module with experts from the different related disciplines. Furthermore, uncertainty must be quantified at each stage and combined to generate a distribution of SCC values.

Regarding CO_2 emissions, it is thus possible to update the SCC using statistical methods and expert elicitation in order to project distributions of GDP, population growth and emissions into the future. In terms of climate portion improvement, the use of a simple Earth system model that satisfies well-defined diagnostic tests is recommended. When doing so, results suggest that the peak impact of a pulse of CO_2 effect on global mean temperature is going to occur sooner, compared with corresponding assumptions in other models, and will have a much bigger impact in terms of climate change. Furthermore, considering that the FUND and DICE models are based on scientific literature from the 1990s, calculations of the damage modules should be improved and existing damage functions should be updated based on the explosion of research on climate damages in more recent decades. Finally, in terms of the discounting module, a discount that more or less obeys the Ramsey formula is recommended. In this case, in scenarios where economic growth is high, damages are discounted at a higher rate than in states where the world economic growth is slow.

• The Global Energy Challenge and Pollution Pricing

Societies around the world must find a way to balance three different and interconnected goals: having inexpensive sources of energy while avoiding severe local pollution problems and preventing disruptive climate change. In practice, finding policies that beneficially move the ball forward on all these goals at once is very difficult.

○ The difficult balance between energy and growth

From historical records, there is not an observed path to a high level of GDP without important energy consumption. In this regard, continued growth in energy demand per capita appears critical today for improving quality of life in emerging economies. Furthermore, energy access remains a major problem in these regions where per capita energy consumption is lower than developed world levels. Therefore, demand will grow rapidly in developing countries: while global energy demand is set to grow by one-fourth between now and 2050, fully 100% of expected growth will occur in emerging market economies, especially in Asia.

A major challenge regarding this increase is that fossil fuels are expected to meet much of this growth. Based on policies in place and committed to at the end of 2016, the International Energy Agency (IEA) indeed expects fossil fuels to supply 72% of the world's primary energy in 2040, compared to 80% in 2019. This high demand and fossil fuel strong-hold on energy supply mainly results from their lower cost relative to cleaner sources of energy. However, fossil fuels increase air pollution, which in turn impacts life expectancy and causes large and heterogeneous impacts on climate change. In other words, the same energy sources that can unlock growth are also causing an increase in mortality and in odds of disruptive climate change.

○ Policy solutions to face markets failures

Energy prices do not include externalities and therefore do not reflect full social costs. Presenting prices in strictly private terms thus heavily favours conventional fossil generation. The introduction of a carbon price can have transformative effect by allowing for pricing externalities. When including climate impact, for instance, at a 3% discount rate and a SCC of $125, coal price goes from 2.9 cents a kilowatt to almost 18 cents (and up to 21.8, when including the particulate impacts of fuel combustion). Under these conditions, coal loses its comparative advantage over renewable energy. The number of countries that have implemented some form of carbon pricing has grown rapidly in recent years. While in 2003 almost no global emissions were priced, the share today is 16% and growing. Yet prices are extremely inconsistent: the average ton of CO_2 around the world is priced at about $2.5. 16% of emissions face a price that is above 0.

A second major policy solution is innovation, which can cause rapid changes in energy. However, related Research & Development (R&D) stills remains a small share of GDP today while investments in it have plummeted from levels reached in the mid-1970s in many countries.

• The cost-efficiency puzzle carbon pricing puzzle

○ Cost Efficiency Approaches (CEA) support procrastination

In terms of optimality concept for carbon pricing, the Cost-benefit Approach (CBA) is considered the holy grail of the SCC. However, it does not reflect the current political debate, such as the quantitative 2°C target set by the EU corresponding to a Cost-efficiency Approach (CEA). This "second best," which implies an intertemporal carbon budget, raises the question of the determination of the optimal growth rate of carbon price to reach this goal. Once this rate is determined, a "third best" CEA, such as the reduction by 55% of carbon emission by 2030 and net-zero in 2050, interrogates whether this target is optimal or not.

The existing results in the literature and CEA models recommend relatively high rates of growth. For instance, the *Commission Quinet 2* in France highlighted carbon values going from 69€/tCO_2 in 2020 to 775 €/tCO_2 by the year 2050, corresponding to an 8% growth rate per year of carbon price. Considering an intertemporal carbon budget, this suggests a very low carbon price today and a very high price in the future. In other words, such models tend to support procrastination and a waiting game postponing the efforts to later times.

○ The importance of uncertainty in carbon price determination

In the case of an intertemporal carbon budget, following the Hotelling's rule, the growth rate of the carbon price should be equal to the risk-free discount rate. In this case, we reach a much smaller rate that the rates recommended by CEA models.

However, uncertainty is a key aspect to consider when calculating carbon price. One indeed does not know how green innovations will evolve, especially given the inter-dependency aspects and electricity storage question that will affect future abatements. Putting in place low carbon prices today by assuming that the necessary technologies will exist by 2050 appears in this sense a very risky "*green bet*". Similarly, economic prosperity's future and carbon budgeting will affect future abatement costs in an uncertain way. Considering these different aspects, the Hotelling's rule cannot be used per se and shall be adapted to determine what is the efficient carbon price growth in expectations when facing uncertainties.

For instance, if green technological progress is the main source of uncertainty in the economy and its growth is stronger than expected, the total and marginal costs will be reduced more than expected. Consumption will be larger in the second period because of the reduced cost of mitigation, and we will observe a negative income elasticity of marginal abatement cost (MAC). In this case, the growth rate of expected carbon price should thus be smaller than the interest rate. Reciprocally, if the future prosperity of the economy is the main source of uncertainty, production and thus emissions will be larger than expected. This will yield larger MAC meaning a positive income elasticity of MAC and a growth rate of expected carbon price bigger than the interest rate.

A two-period model - with macro-uncertainties regarding the total productivity of factor (TFP) about the MAC function and the carbon budget - is calibrated to simultaneously determine the efficient risk-free rate, the efficient risk-premium as well as the efficient carbon price today and the growth rate of the expected future carbon price. Solving the problem numerically with a small equilibrium interest and large risk premium, compatible with what we observe on the market, highlights a positive correlation between consumption and MAC. In other words, uncertainties about the future justify using a growth rate of carbon price larger than the risk-free rate, violating the Hotelling rule. This leads to an optimal growth rate of expected carbon price of 3.47% (larger than the risk-free rate, at around 1%). This is much smaller than today's recommendation on how to allocate effort on how to reduce emission over time.