SUMMARY REPORT
SEPTEMBER 2019

The Economic Potential of Article 6 of the Paris Agreement and Implementation Challenges

Ahead of the 2019 United Nations Framework Convention on Climate Change (COP 25) in Chile in December 2019, where decisions on how to implement Article 6 of the Paris Agreement are expected to be made, IETA and the university of Maryland, with co-funding from the Carbon Pricing Leadership Coalition, undertook an assessment of the economic potential of Article 6, and the possible implications of the various design options being negotiated. The results of this assessment are summarized here.

Key messages

- Article 6 has the potential to improve the economic efficiency of implementing Nationally Determined Contributions (NDCs).
- These efficiencies could halve the cost of implementing NDCs, to $250 billion a year (in 2030) or, if the cost remains constant, increase the amount of emissions removed by 5 gigatons of carbon dioxide ($GtCO_2$) a year.
- Achieving these benefits requires careful consideration of the framework design and implementation.
- Poorly designed rules could have the opposite effect.
- Additional research is needed before COP 25 in Chile.

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BACKGROUND

The Paris Agreement established an international framework for addressing climate change rooted in national action. Parties pledge to achieve short-term (to 2030) domestic goals through NDCs and report on their progress to achieving these goals. Unfortunately, current NDC pledges are insufficient to limit the average surface temperature increase to the agreed goal of 1.5°C (IPCC, 2018). There is an urgent need for parties to become more ambitious in their commitments.

Article 6 of the Paris Agreement allows parties to produce internationally transferred mitigation outcomes (ITMOs). ITMOs have the potential to lower the cost of abatement and so, it is hoped, increase appetite for more ambitious pledges. About half the parties who have submitted NDCs have signaled an interest in invoking Article 6 (World Bank and Ecofys, 2018). To date, however, there are no rules to guide how this should be done. Finalizing these guidelines will take center stage at COP 25.

METHODOLOGY

The open source Global Change Assessment Model (GCAM), which considers the energy, economy, agriculture and land-use systems of 32 geopolitical regions across the globe, was used to construct four different scenarios to assess the potential value of Article 6 (Joint Global Change Research Institute [JGCRI], 2017 and 2018). These are:

- **A reference scenario**, which assumed no new policies or actions to reduce greenhouse gas emissions after 2010 (GCAM's calibration year).
- **An independent implementation of NDCs (I-NDC) scenario**, which assumes that countries meet their 2030 NDC commitments through independent implementation and continue decarbonizing on their own.
- **A cooperative implementation (C-NDC)** scenario, which assumes that countries meet their NDC commitments making use of Article 6 collaboration.
- **An enhanced ambition (E-NDC) scenario**, which assumes that the funds each country would have spent on pursuing its NDC independently is used to pay to mitigate carbon emissions through cooperative mechanisms.

Double counting, a key issue in COP 24 negotiations, does not occur in these models. Targets established in NDCs come in a variety of forms and modeling them requires a translation of each NDC into an absolute target. Our translation of NDC obligations is largely consistent with other translations performed in the literature.

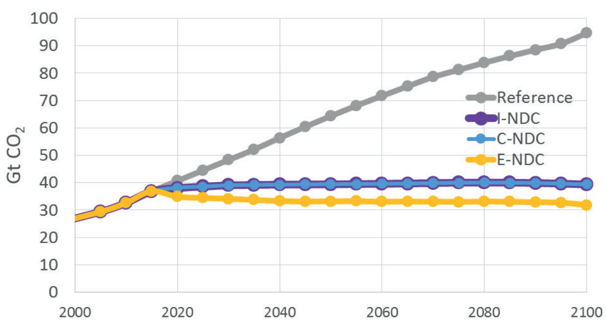
Please see the full report for a detailed discussion of the variables considered and calculations of potential enhanced ambition.

KEY FINDINGS

Figure 1 shows that I-NDC and C-NDC scenarios have identical global emissions by 2100. However, since cooperative mechanisms are more economically efficient, C-NDC creates an opportunity to increase mitigation ambitions without increasing cost.

By 2030, global emissions for the I-NDC scenario is roughly 5 $GtCO_2$/year greater than the E-NDC scenario, with continued ambition as per Fawcett *et al.* (2015), over the course of the century exceeding 520 $GtCO_2$. These additional benefits can only be made achieved through the perfect implementation of Article 6.

FIGURE 1 Global fossil fuel and industrial CO_2 emissions in the reference, I-NDC, C-NDC, and E-NDC scenarios



The financial size of the virtual carbon market is about USD$167 billion/year in 2030, increasing to $347 billion/year in 2050 and reaching $1.2 trillion/year in 2100. As Figure 2 shows, enhanced ambition under the E-NDC scenario roughly doubles the marginal cost of carbon in 2030 compared to the C-NDC scenario, while I-NDC costs remain stable at a higher level.

FIGURE 2 Shadow prices of CO_2 in the I-NDC, C-NDC, and E-NDC scenarios

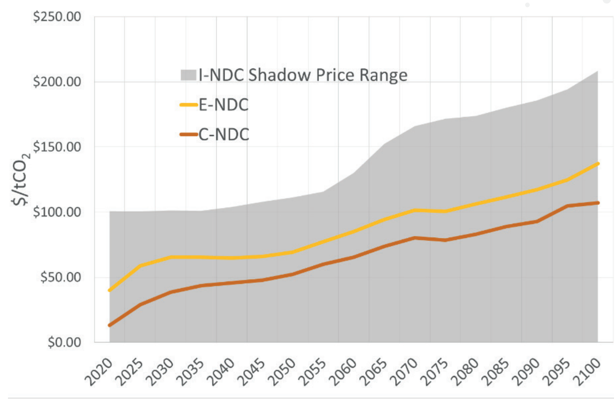
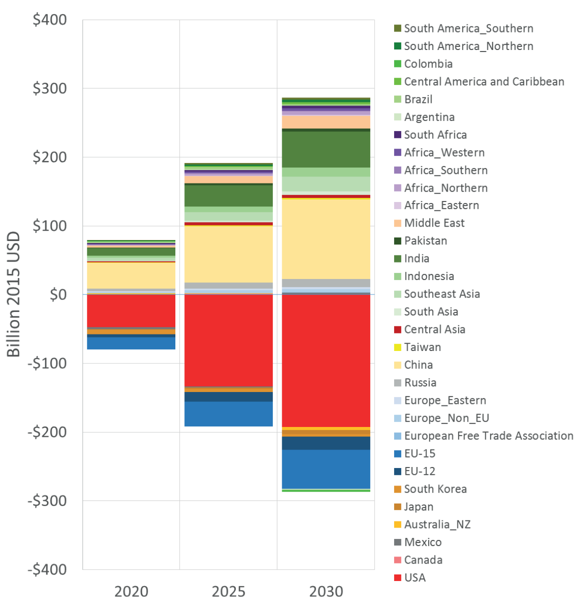


Figure 3 depicts the financial transfers required to ensure that each of the 32 regions carries identical total cost as in the I-NDC scenario. These are equivalent to the value of ITMOs that would be created through Article 6 transactions in the E-NDC scenario. The implied physical emissions trades between regions under the E-NDC scenario would be about 4.4 $GtCO_2$/year in 2030, similar to emissions redistributed under C-NDC.

FIGURE 3 Financial transfers necessary to equate mitigation cost in each region in the E-NDC and I-NDC scenarios, valued at the E-NDC shadow price of carbon in the E-NDC scenario



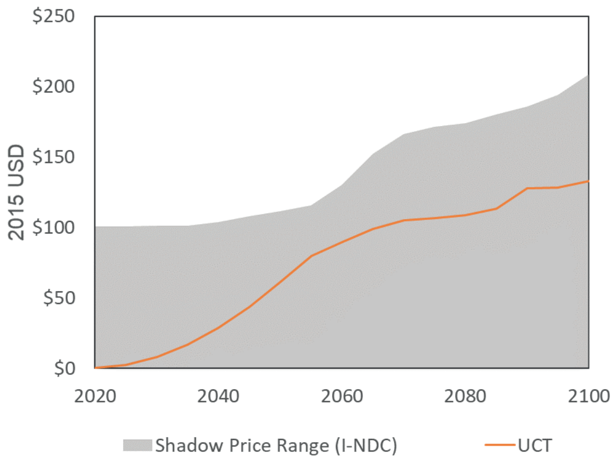
I-NDC SCENARIO VARIATION: IMPACT OF RESTRICTING LAND USE

The I-NDC scenario considers the effects of policies that constrain CO_2 emissions from energy and industry. The effect of land use on emissions is excluded—even though land-use policies are important considerations for the cost effectiveness of climate change mitigation. A fifth scenario that considers the effect of a universal carbon tax (UCT), which constrains all CO_2 emissions regardless of their origin, was therefore developed.

In the I-NDC UCT scenario, CO_2 emissions from land use are valued on par with CO_2 emissions form fossil fuel and industrial sources. Projections under this scenario indicate that integrating terrestrial and energy systems could lower the cost of meeting the same mitigation target. This is consistent with the findings of other studies (Tavoni *et al.*, 2007; Wise *et al.*, 2009).

The shadow price of carbon in 2030 is as low as \$8/tCO_2 in the UCT scenario (Figure 7), similar to the estimate of Fujimori *et al.* (2016). The physical amount of carbon traded in the virtual market is roughly 5.4 GtCO_2 in 2030, 25% bigger than that in the I-NDC scenario. However, because of the lower shadow price, the financial size of carbon market is much smaller, about \$43 billion.

FIGURE 4 Shadow prices of CO_2 in the I-NDC-UCT scenario



IMPACT OF U.S. WITHDRAWAL

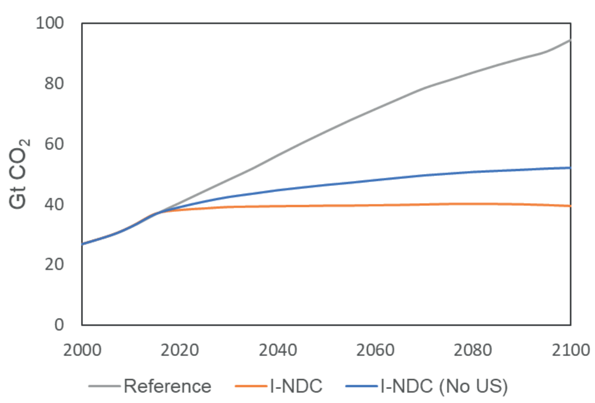
Two scenarios to assess the effect the U.S. withdrawing from the Paris Agreement—as announced in 2017—could have on the implementation of Article 6 were also modelled:

- The **I-NDC (no U.S.)** scenario assumes that all countries except the U.S. meet their NDC commitments through 2030 and continue at the same level of decarbonization effort required to achieve their NDCs beyond 2030. The U.S. makes no effort to reduce emissions after 2010 and remains on its reference trajectory, moderated only by interactions with other countries through international energy and commodity markets. This scenario excludes the effects of mitigation measures undertaken by U.S. states, local governments, and non-government actors, which could significantly affect the country's emissions (America's Pledge Initiative on Climate, 2018).

- The **C-NDC (no U.S.)** scenario assumes that all countries except the U.S. implement their NDCs by purchasing and selling ITMOs, so collectively reducing emissions beyond 2030. The U.S. makes no effort to reduce emissions after 2010 and does not participate in the emissions trading under Article 6.

In the I-NDC (no U.S.) scenario, U.S. emissions continue to rise while the other 31 regions keep the same level of ambition as the I-NDC scenarios. With no mitigation effort by the U.S., global CO_2 emissions from energy and industry increase by 9% in 2030, 18% in 2050, and 32% in 2100, compared with the I-NDC scenario (Figure 9).

FIGURE 5 Global fossil fuel and industrial CO_2 emissions in the I-NDC and I-NDC (No U.S.) scenarios

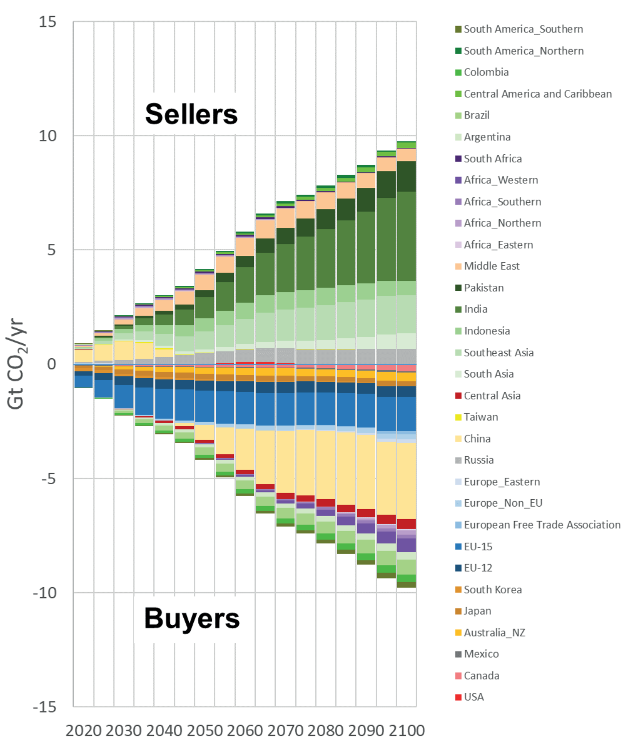


Shadow prices of carbon in an I-NDC (no U.S.) scenario are lower, reaching up to \$94/tCO_2 in 2030, \$100/tCO_2 in 2050, and \$185/tCO_2 in 2100. Cooperative implementation (C-NDC, No U.S.) would reduce the shadow price to \$7/tCO_2 in 2030, \$40/tCO_2 in 2050, and \$88/tCO_2 in 2100.

The size of the virtual physical carbon market is much smaller without U.S. participation—only 2.1 GtCO_2/year in 2030, compared with 4.3 GtCO_2/year in 2030 with U.S. participation. The financial size of the virtual carbon market is also much smaller, approximately \$15 billion in 2030, \$164 billion in 2050, and \$855 billion in 2100.

The U.S. is the second largest GHG emitter globally. Without its participation, both China's role and the amount of carbon it purchases change significantly: without U.S. participation, China changes from a potential seller to a potential buyer in 2045. With U.S. participation, the change happens in 2060. The amount of carbon China will purchases from the virtual market also increases, from 2.2 GtCO_2/year in 2100 with U.S. participation to 3.3 GtCO_2/year in 2100 without U.S. participation.

FIGURE 6 Carbon market without U.S. participation



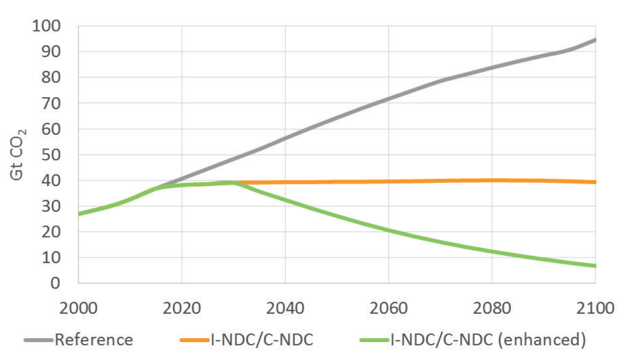
INCREASED AMBITION POST-2030

Current NDC commitments are not enough to limit global temperature rise to below 2°C (Fawcett *et al.*, 2015; Rogelj *et al.*, 2016; IPCC, 2018). Countries need to increase their ambitions over time. The following scenarios were developed to assess the value of Article 6 after 2030:

- **I-NDC-Increased** assumes that countries implement their NDCs to meet their commitments through 2030 and then accelerate efforts to decarbonize their economies, opting for an independent approach in both instances.
- **C-NDC-Increased** assumes that countries implement their NDCs to meet their commitments through 2030 and accelerate efforts to decarbonize their economies, opting for a cooperative approach in both instances.

In both scenarios, we assume that countries decarbonize their economies at an accelerating rate of 5% per year after 2030, which is consistent with the Paris-Increased Ambition scenario in Fawcett *et al.* (2015). Compared with I-NDC and C-NDC scenarios, both I-NDC-Increased and C-NDC-Increased scenarios reduce global CO_2 emissions by 34% in 2050 and 83% in 2100 (Figure 7), and decrease the probability of temperature change exceeding 2°C in 2100 by 26% (see Fawcett *et al.* for the probabilities of temperature rise).

FIGURE 7 Global fossil fuel and industrial CO_2 emissions in the I-NDC-Increased and C-NDC-Increased scenarios

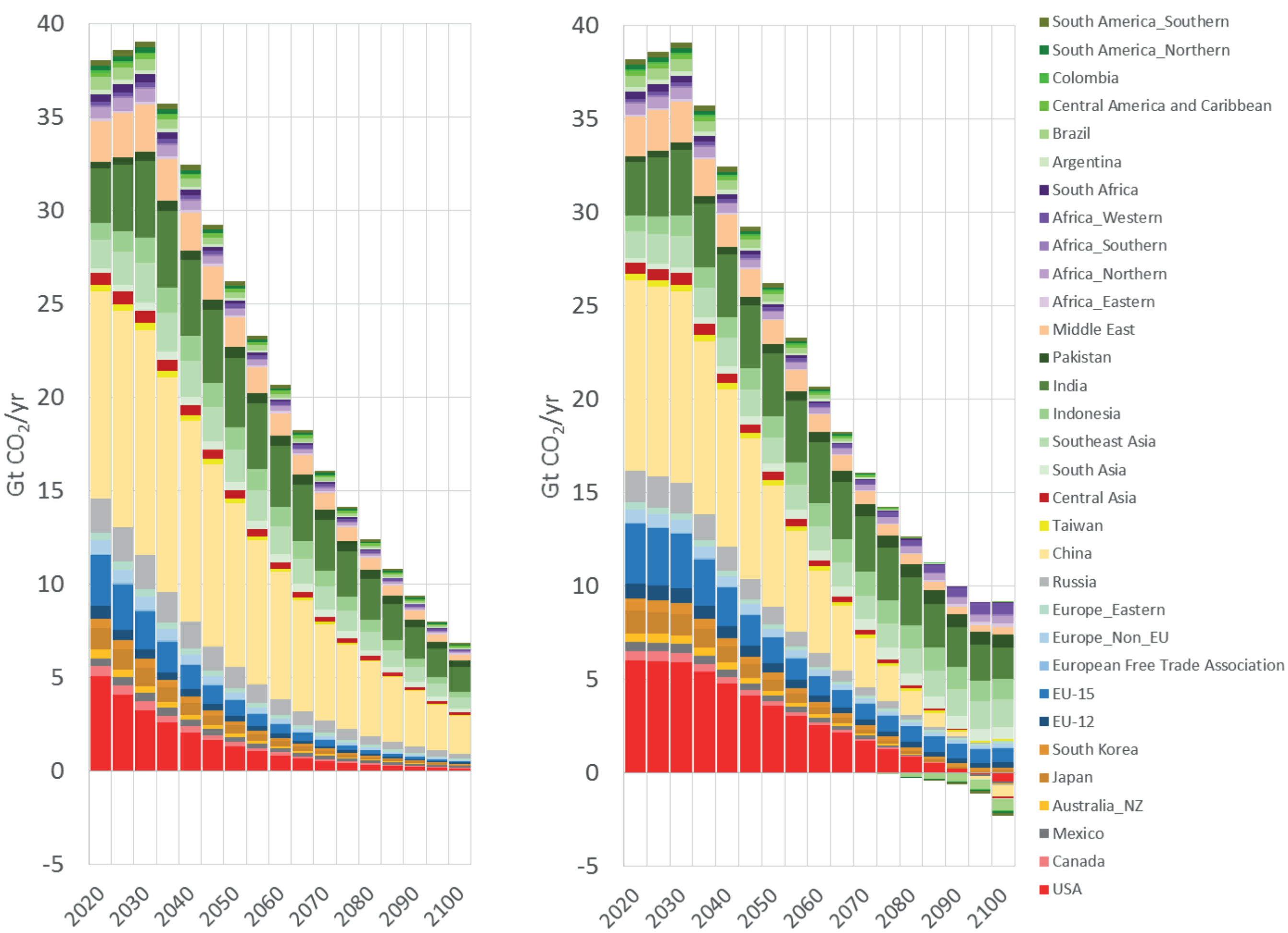


More ambitious mitigation actions after 2030 result in significant reduction in CO_2 emissions in all regions (Figure 8). At the same time, the shadow price of carbon in Increased scenarios are higher and more consistent across regions compared with the I-NDC and C-NDC scenarios, as all regions employ more robust mitigation efforts. The shadow price of carbon in the I-NDC-Increased scenario ranges from \$95/tCO_2 to \$159/ tCO_2 in 2050, and \$281/tCO_2 to \$338/ tCO_2 in 2100. In the C-NDC-Increased scenario, the shadow price of carbon is \$110/tCO_2 in 2050 and \$304/tCO_2 in 2100.

FIGURE 8 CO_2 emissions and carbon market with more ambitious post-2030 mitigation

Panel A: I-NDC increased scenario CO_2 emissions

Panel B: C-NDC increased scenario CO_2 emissions



Increased ambition across all regions would reduce the virtual physical carbon market to about 3.8 $GtCO_2$/year in 2050 and 5.3 $GtCO_2$/year in 2100. However, the higher shadow price of carbon would result in the market increasing to about $419 billion/year in 2050 and $1.6 trillion/year in 2100.

The list of potential buyers and sellers would also change, especially in the second half of the century. With large-scale energy systems and greater flexibility to switch fuel and reduce carbon emissions at lower costs, China will be the biggest seller in the virtual carbon market throughout the century, with the U.S. also becoming a seller towards the end of the century.

DISCUSSION

Article 6 has the potential to either lower the cost of achieving their NDCs or increase regional ambitions in the first commitment period. Yet implementing Article 6 remains a challenge, in part because the rules around the creation and trade of ITMOs are not clear, given the heterogeneity in targets and policies across NDCs (Das, 2015; Hood and Soo, 2017; Mehling *et al.*, 2018; Rose *et al.*, 2018).

Article 6 may create peer pressure if countries choose to import only from regions with credible NDCs (Mehling *et al.*, 2018; Iyer *et al.*, 2015; La Hoz Theuer, 2018; Peters *et al.*, 2017). Cost savings achieved through Article 6 could be used to enhance ambition after countries achieve their initial pledges (Metcalf and Weisbach, 2011; Calvin *et al.*, 2015; Ostrom, 2010; Lutter and Shogren, 2002; Becker, 2000; Hohne *et al.*, 2017).

Rules to guard against lack of ambition after 2030 could include limiting ITMO sales by a proportion that is inverse to actual emissions, or phasing in of ratcheting mechanisms. These steps may also be necessary to avoid linkage of programs leading to an increase in overall emissions (Helm, 2003).

Article 6 may become necessary if NDCs are to approach zero, enabling regions that are unable to mitigate to net zero to trade with those that are able to reach net negative emissions. Cooperation will shift emissions mitigation to places with an advantage in terms of capital and infrastructure for emissions mitigation actions.

Rules that seem effective at project scale can behave very differently at macro scale (Calvin, *et al.,* 2015; Rockstrom *et al.*, 2017). The issue of leakage, including leakage across sectors, will be important to explore. Metcalf and Weisbach (2011) have initiated debate in economics literature (e.g. Bodansky *et al.*, 2016) regarding how to establish linkages between disparate programs such as emissions trading systems and carbon taxes or regulatory schemes while avoiding double-counting or emissions leakage. Scenario modeling enables researchers to test rules for Article 6 to obtain a clear understanding of interactions at scale.

The guidance for Article 6, which is under development and due for adoption at COP25, is expected to elaborate on the rules and implementation details needed to operationalize the Paris Agreement, including Article 6. Carefully constructed, these rules could result in substantial cost savings that translate to enhanced mitigation, while poorly written rules could frustrate the performance of the Paris Agreement.

FUTURE RESEARCH

The role of the land-use sector under Article 6 of the Paris Agreement would benefit from more quantitative analysis via an integrated assessment model. However, a qualitative analysis that describes protocols for offset quality related to the land-use sector and assesses strategies for addressing leakage of emissions would complement further quantitative analysis.

Further quantitative exploration is needed into the implications of reinvesting cost savings from cooperative carbon trading back into enhanced ambition, as well as into potential mechanisms to encourage that outcome. An elaboration on the extent to which cost savings from international trading under Article 6 increases the probability of achieving a target of 2°C or lower would provide insight into how to fill the gap between current pledges and climate targets.

A qualitative analysis that contemplates the extent to which countries will choose to reinvest cost savings into enhanced ambition, rather than simply keeping those savings, would provide a starting point for creating incentives and rules to encourage enhanced ambition.

The rigorous analysis of how market access through "carbon clubs" could encourage use of specific ratcheting mechanisms, intended to incentivize enhanced ambition over time, would be particularly helpful as negotiators continue their work to fill the emissions gap. Characterizing the combination of clubs and ratcheting mechanisms, then modeling them in a quantitative framework, is a promising area for future research.

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