Modeling Economic Impacts of Alternative International Climate Policy Architectures: A Quantitative and Comparative Assessment of Architectures for Agreement

by Valentina Bosetti, Carlo Carraro, Alessandra Sgobbi, & Massimo Tavoni

Overview

With broad recognition that a coordinated global effort is needed to address climate change, negotiations are already underway to define a new international climate agreement. Various architectures for such an agreement have been proposed. This paper undertakes a first-of-its-kind comparison of some prominent options using a common framework to assess four features of these architectures: economic efficiency; environmental effectiveness; distributional implications; and political acceptability, as measured in terms of feasibility and enforceability. The aim is to derive useful policy insights for designing a post-Kyoto agreement.

Discussion

The policy architectures compared in this paper are summarized below. Each makes different trade-offs in scope and timing, with implications for cost, environmental effectiveness, and political feasibility.

1. Global Cap-and-Trade with Redistribution: In this benchmark scenario, all nations participate immediately in a global cap-and-trade system designed to stabilize atmospheric CO_2 at 450 parts per million (ppm) by 2100. Permits are allocated to all countries on an equal per-capita basis.

2. Global Tax Recycled Domestically: All countries apply a globally-consistent carbon tax designed to achieve the same stabilization trajectory as above. Revenues from the tax are recycled domestically and implementation begins immediately.

3. Reducing Emissions from Deforestation and Degradation: Same as the first scenario, except credits from avoided Amazon deforestation are included in the permit market.

4. Climate Clubs: In this scenario, a group of mostly advanced economies agrees to abide by its Kyoto target and reduce GHG emissions 70% below 1990 levels by 2050. Other fast-growing countries and regions begin gradual efforts to reduce emissions below business-as-usual (BAU), but converge to the same level of reductions as the first group after 2050. All remaining countries face no binding targets, but their emissions are limited to BAU.

5. Burden Sharing: Developed (Annex 1) countries commence abatement immediately, with the burden shared on an equal per-capita basis. Binding emissions targets are extended to all other countries, except those in sub-Saharan Africa, in 2040.

6. Graduation: Countries adopt binding emission targets as they reach specified criteria for income and emissions. Annex 1 countries compensate for the delayed entry of non-Annex 1 countries by undertaking additional reductions as required to achieve a 450 ppm stabilization trajectory.

7. Dynamic Targets: Different countries adopt different targets over time depending on current and projected emissions, income, and population.

8. R&D and Technology Development: No binding emissions targets; instead all countries contribute a fixed percentage of GDP to an international fund for developing low-carbon technologies.

KEY FINDINGS & RECOMMENDATIONS

The authors apply the WITCH climate-energy-economy model to assess each proposed architecture along four metrics: environmental effectiveness (measured as expected temperature change above pre-industrial levels in 2100); economic efficiency (measured as change in gross world product, or GWP, relative to BAU); distributional implications (using the Gini Index to measure income inequality across different regions of the world in 2100); and potential enforceability (measured by changes in global and regional welfare with respect to the status quo). Several policy-relevant insights emerge:

- *All the policy architectures evaluated in this analysis produce warming above the 2°C target envisaged by the IPCC and the European Commission.* More drastic measures than any of those modeled for this analysis will be required to meet the target.

- *There is a clear trade-off between environmental effectiveness and cost.* The inclusion of credits for avoided deforestation helps reduce cost somewhat, but estimated gross world product (GWP) losses in all the scenarios designed to achieve CO_2 stabilization at 450 ppm (Scenarios 1, 2, 3, 5, 6) exceed 1%. The Climate Clubs and Dynamic Targets scenarios (4, 7) are significantly less costly, but also less effective. The R&D-only scenario (8) actually leads to slight gains in GWP, but it is also the least effective in terms of reducing emissions.

- *There is a clear trade-off between environmental effectiveness and enforceability.* If one assumes that countries' willingness to participate will depend on the expected welfare effects of the policy, then the more stringent architectures—because they are more costly—will also be the most difficult to enforce.

- *Any of these architectures would produce a more fair distribution of income in 2100 relative to the current situation.* In the more stringent scenarios (i.e., those designed to stabilize CO_2 at 450 ppm), however, these gains in equality occur in the context of significant overall GDP losses. Of the architectures modeled, the most egalitarian are Climate Clubs, Graduation, and Dynamic Targets (4, 6, 7) because they distribute the abatement burden according to per-capita income and emissions. The inclusion of credits for avoided deforestation (3) also improves equity because most forest-related abatement opportunities are located in developing countries.

CONCLUSION

From a cost and enforceability standpoint, GHG stabilization at 450 ppm for CO_2 only (550 ppm CO_2-equivalent for all GHGs) is hardly achievable. However, there may exist a strategy of progressive commitments, in which future binding targets are set to achieve consensus in developing countries, whereas developed countries move first, that can achieve GHG stabilization very close to 450 ppm. An extended, possibly global, carbon market, even without global commitments to reduce emissions, helps reduce costs. In addition, including non-CO_2 gases and credits for avoided deforestation further reduces costs. Nonetheless a basic trade-off between economic impact and environmental protection remains.

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ABOUT THE HARVARD PROJECT ON INTERNATIONAL CLIMATE AGREEMENTS

The goal of the Harvard Project on International Climate Agreements is to help identify key design elements of a scientifically sound, economically rational, and politically pragmatic post-2012 international policy architecture for global climate change. It draws upon leading thinkers from academia, private industry, government, and non-governmental organizations from around the world to construct a small set of promising policy frameworks and then disseminate and discuss the design elements and frameworks with decision-makers. The Project is co-directed by Robert N. Stavins, Albert Pratt Professor of Business and Government, John F. Kennedy School of Government, Harvard University, and Joseph E. Aldy, Fellow, Resources for the Future. Major funding for the Harvard Project on International Climate Agreements is provided by a generous grant from the Climate Change Initiative of the Doris Duke Charitable Foundation.

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