ESTIMATING POWER SECTOR LEAKAGE RISKS AND PROVINCIAL-LEVEL IMPACTS OF CANADIAN CARBON PRICING

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Overview

Carbon pricing systems have emerged in Canada at provincial and federal levels as a means to reduce CO_2 emissions. However, cross-border electricity trade with the U.S. is extensive, and although Canada is currently a net exporter, policy changes could alter these trade dynamics. Since CO_2 emissions are currently unregulated in most U.S. states, there is a concern that this incomplete regulatory coverage will lead to emissions leakage, as electric generation and emissions shift toward these unregulated locations. This analysis assesses potential power sector leakage and distributional implications across provinces from Canadian carbon pricing.

Methods

This analysis uses the North American Regional Economy, Greenhouse Gas, and Energy (REGEN) modeling framework to evaluate leakage risks and province-level impacts. REGEN is a state-of-the-art capacity planning and dispatch model that uses an innovative algorithm to capture hourly joint variability in load, wind, and solar output in a multidecadal model (EPRI, 2018; Blanford, et al., 2018). REGEN makes linked decisions about new generation investments and hourly system dispatch across the U.S. and Canada, and co-optimizes transmission investment and trade flows.

To evaluate the impact of Canadian carbon pricing, the analysis begins with a counterfactual reference scenario with all other on-the-books policies and regulations (e.g., coal phaseouts, renewable mandates). All scenarios assume that the U.S. follows its current patchwork approach to policy at the state and regional level (e.g., California's clean energy mandate and economy-wide emissions targets, Regional Greenhouse Gas Initiative, state renewable mandates) but does not implement a federal climate policy. Results in this scenario can be compared with the Canadian carbon pricing scenarios, which assume that provinces implement CO_2 policies as proposed (including the federal backstop for provinces that do not adopt their own pricing systems). The analysis also examines scenarios with three mechanisms for limiting leakage: a border carbon adjustment through an import tariff, an autarky constraint to enforce local generation in individual provinces to be at least 90% of load, and an output-based pricing system based on the proposed Canadian federal backstop.

Results

Model results demonstrate how emissions leakage through trade adjustments can be non-trivial fractions of the intended emissions reductions even in the presence of leakage containment measures. Magnitudes of long-run leakage rates from Canadian carbon pricing depend on market and policy assumptions (e.g., natural gas prices, timing of future U.S. CO_2 policy), ranging from 13% (high gas price scenario with border carbon adjustments) to 76% (lower gas price scenario without antileakage measures), which are higher than reported literature values for unilateral national policies. Without antileakage measures, carbon pricing reduces cumulative CO_2 emissions in Canada through 2050 by 61% relative to the reference, lowering cumulative emissions by 2.0 million metric tons (mmt) CO_2. However, U.S. emissions simultaneously rise by 1.5 mmt-CO_2, and the resulting leakage rate of 76% is on the higher end of the published literature (Bistline and Rose, 2018). Even the presence of carbon caps in northern U.S. states like RGGI is not enough to disincentivize leakage, as electricity price differentials are still significant enough for U.S. states to reduce dependence on lower-CO_2 but higher-cost imports from Canada.

Overall policy costs (i.e., the incremental net present value of the cost of power procurement across the time horizon) are low relative to the total system cost. Summing across all electric sector expenditures (including capital costs, fuel costs, operation and maintenance costs), the NPV of total system costs increase about $2.6 billion with carbon pricing, which is about 1% of reference scenario costs. Although national costs are low, economic impacts vary across provinces. Alberta contributes 40% of cumulative emissions reductions for Canada, so it is not surprising that it bears the highest cost burdens as well. As existing capacity retires, Alberta replaces generation from retiring units with natural gas and wind in the reference scenario but rely on imports when carbon pricing is added.

When leakage containment measures are implemented, net emissions and leakage rates decrease, but gross emissions in Canada and policy costs increase. Leakage persists in alternate scenarios with constrained transmission expansion, higher natural gas prices, and U.S. adoption of carbon pricing, but leakage rates decrease under these conditions.

Conclusions

These results have several implications for policymakers, analysts, and other stakeholders. First, the analysis indicates that changes to Canadian policy alone will not significantly alter aggregate North American emissions. Not only does international leakage offset a large fraction of domestic reductions, but the scale of Canada's emissions and its low CO_2 intensity suggest that additional U.S. policy ambition would be necessary for North America's emissions trajectory to be more consistent with the Paris Agreement (Rose, et al., 2017). Second, the observation that antileakage measures can simultaneously decrease net emissions and increase policy costs (or vice versa) is more broadly indicative of tradeoffs between environmental and economic outcomes in policy design. Energy-economic modeling can help to quantify these tradeoffs, but stakeholders inevitably must settle on appropriate and acceptable compromises across these competing objectives. Finally, the non-trivial emissions leakage observed in this analysis across scenarios (between 13% and 76% of the expected decrease in regulated emissions) suggests that quantifying policy-induced economic and environmental impacts of Canadian carbon pricing requires consideration of potential cross-border impacts and a modeling framework that is capable of evaluating endogenous changes in investment and dispatch in the U.S. and Canada.

References

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