Optimal Unilateral Climate Policy

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In the immediate future, we are planning on submitting a paper that addresses the design of climate change policy in an international setting. That paper, we believe, has a number of novel results that have important implications for the design of domestic carbon policies. Although the intuitions behind the results are straightforward, the model used to derive those results is not readily accessible. If accepted to present at the NBER conference on Environmental and Energy Policy and the Economy, we intend to write a shorter, more accessible version of the paper that highlights the basic economics, the results, and their importance for the design of domestic carbon policy. In this abstract, we describe our model and the intuitions behind our results. We also present results from a calibrated simulation of the model.

The question we address is how a nation or coalition of nations should design a climate change policy if other nations do not also impose a climate change policy. The question is of first order importance for solving the problem of climate change. Nations are reluctant to impose strict policies if other nations do not because of fears that emissions will simply relocate to places with fewer restrictions, a problem known as leakage. Concerns about leakage were one of the reasons that the United State did not ratify the Kyoto Protocol. The problem retains significance in a Paris-Agreement world because that agreement does not attempt to harmonize policies across nations.

Because of its importance, there are a large number of studies of the problem. The vast majority use CGE models to simulate policies. While useful, CGE models are not convenient for determining the optimal climate policy. In addition, because of the complexity of the models used, that approach does not provide a full understanding of the underlying economics of the problem and its solution.

To further our understanding of climate policy in an international setting, we develop an analytic general equilibrium model of international trade, where one region (Home) imposes a carbon policy and the rest of the world (Foreign) does not. The model stacks Markusen (1975) and Dornbusch, Fisher, and Samuelson (1977). We interpret Markusen as a model of extraction and trade in fossil fuels, with DFS bringing in production, trade, and consumption of goods produced with fossil fuels. Following Böhringer, Lange, and Rutherford (2014), we restrict policies adopted by Home to those that do not make Foreign worse off. Our solution strategy borrows from Costinot, Donaldson, Vogel, and Werning (2015), and provides an optimal allocation of goods and

services under a unilateral carbon policy. We then show how that allocation can be implemented in a decentralized equilibrium using taxes and subsidies. We also solve the model for a number of constrained optimal policies, which when implemented line up with conventional carbon taxes, such as taxes on emissions from production or those taxes combined with border adjustments.

Solutions in all these cases have three common underlying principles. The first is that the planner uses all the tools it has available. The economy in our model has three sectors: extraction of energy, the use of energy in production, and the consumption of goods (produced with energy) and services. When the planner faces no constraints on policy, it controls all three sectors in Home and, to the extent that Home trades with Foreign, it controls activities in Foreign, subject to Foreign actors operating in a market equilibrium. For example, the planner can require goods produced in Foreign that are imported to Home be produced with a specified emissions level, and similarly, the planner can require Home's exporters to produce with a specified emissions level. The planner uses all of these levers to set its optimal policy; it uses the broadest possible policy. With constrained policies, it has fewer levers, resulting in less effective policies.

Second, climate policies in Home create wedges between the price of energy seen by Foreign actors and the optimal price. For example, the price of energy seen by Foreign extractors will not equal the planner's marginal valuation of extracting a unit of energy. Similarly, the price of energy seen by Foreign producers will not equal the planner's marginal valuation of energy when used. Home's policy balances these wedges.

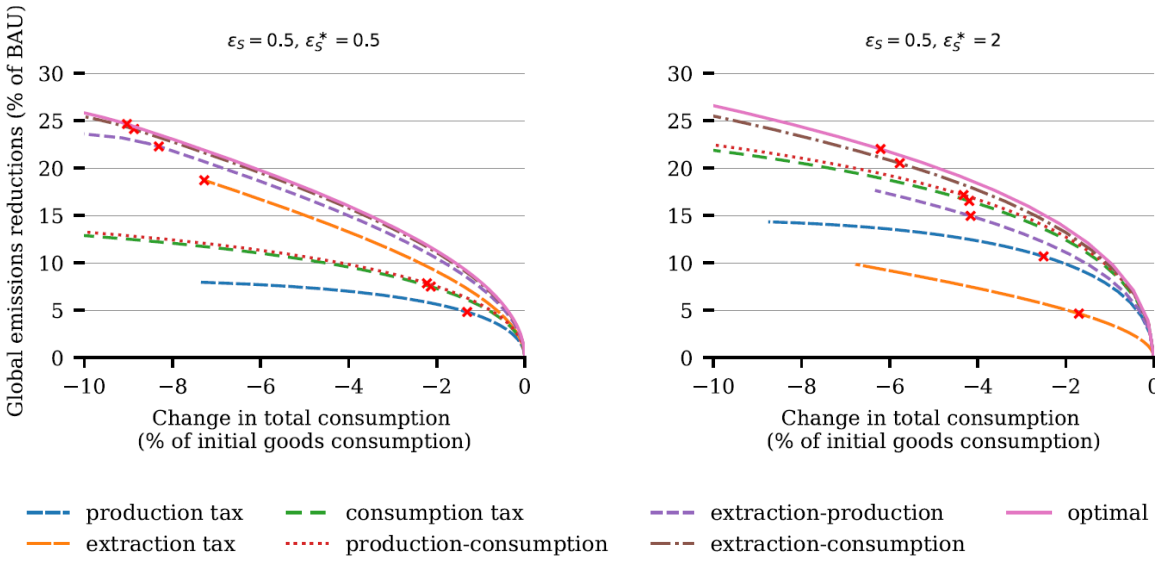
Third and relatedly, Home's optimal policy combines taxes on the supply of energy and the demand for energy. Taxes on supply drive up the price of energy seen by Foreign actors while taxes on demand lower the price of energy. Combining taxes on supply and on demand allows the planner to moderate the effect on the price of energy seen by Foreign actors, thereby the costs of the various wedges.

The optimal policy combines all three principles. It can be implemented by imposing (1) a nominal tax on the carbon content of domestic extraction of energy at a rate equal to the Pigouvian rate (global marginal harm); (2) a border adjustment on the carbon content of imports and exports of energy and imports (but not exports) of goods, all at a common rate that is lower than the extraction tax rate; and (3) a per-unit export subsidy designed to expand Home's export margin. The first two features combine taxes on supply and demand, as just discussed. The third feature can be

thought of as expanding the planner's control over the emissions-intensity of goods consumed in Foreign.

To get a sense of the gains from implementing these features, we calibrate and simulate the optimal policy and compare it to more conventional policies such as taxes on extraction or on emissions from domestic production. In our base calibration, we assume that the OECD imposes a carbon policy and the rest of the world does not. Figure 1 provides a sample simulation. It shows the global emissions reductions (y-axis) for a given cost to Home (x-axis) for seven different policies: the optimal policy, conventional policies, and optimal combinations of conventional polices such as a combination of a tax on extraction and a tax on emissions from production. We show the results for two different values of the elasticity of energy supply in Foreign.

Figure 1



As can be seen, the optimal policy significantly out performs conventional policies. For example, the most commonly proposed policy is a production tax (blue dashes). Under either calibration, this policy is substantially inferior to either the optimal policy or hybrids of conventional policies.

Our current paper does not explore implementation costs in any detail. Nevertheless, we believe that some of the hybrid polices, a hybrid of an extraction and production tax in particular, would be simple to implement and likely legal under the WTO. Yet such a hybrid could significantly outperform conventional approaches. As a result, we are anxious to communicate our results to policy makers.