SSHRC partnership grant proposal – Emmanuel Murray Leclair

Recent papers in the optimal carbon tax literature (most notably Golosov et al. 2014) find that a Pigouvian carbon tax on fossil fuels (where the tax rate equals the marginal externality damages of pollution) is optimal and leads to the planner's allocation even in a modern model featuring elaborate production structure, dynamic management of non-renewable resources and general equilibrium. However, one important assumption is made on the existence of an aggregate constant elasticity of substitution (CES) production function with a finite elasticity of substitution between fossil fuels. One of the reasons why this is assumed is because this line of research investigates an environmental externality which affects the entire world, and micro data from all countries is difficult to find and compile in a single database to deal with heterogeneity. This may not be a problem if plants and firms themselves use a CES or a similar homothetic production functions which are known to aggregate quite nicely.

However, these production functions always imply an interior solution in each input, and I provide consistent evidence across multiple data-sets that not only do plants only switch between fuels in an all or nothing and permanent fashion, they almost never mix between fossil fuels at a given time[1]. In this paper, I rationalize these stylized facts by considering fossil fuels as perfect substitutes in providing energy, which is the actual input needed in production. In this context, a limiting production function where the elasticity of substitution goes to infinity with fixed switching costs, firms will always choose corner solutions in all but one fossil fuel, and they will switch between fuels only if the per energy unit price of their current fuel becomes more expensive than the alternatives. Moreover, there will be a productivity threshold such that only firms above that threshold switch between fuels because higher productivity implies larger marginal gains from lower prices.

I then show that relaxing these canonical assumptions is not innocuous. Indeed, I use an example with two fuels to show that a typical pigouvian carbon tax where the relative tax rate reflects the relative pollution intensity of each fuel is not always optimal. This is because perfect substitutability and fix switching costs imply two margins in firms' input choices: the choice of which fuel to use at the extensive margin and the quantity of fuel to use at the intensive margin. In contexts where the price of the dirtier fuel is much lower than the price of the cleaner fuel, a typical carbon tax won't raise the relative price of dirty fuel enough to incentivize firms to switch towards the cleaner fuel. In these situations, a larger relative tax rate on the dirty fuel, a tax that only affects the dirty fuel or even a tax on the dirty fuel coupled with a subsidy on the cleaner fuel can increase both aggregate output and profits while achieving the same emission target as the pigouvian carbon tax. This issue does not appear when fuels are imperfect substitutes because any input price variation always features extensive margin variation. This situation is particularly relevant in India because the price of the most polluting fuel (Coal more than three times more expensive than the price of the least polluting fuel (Natural gas).

Lastly, I show that this understanding of firm pollution decisions opens the door to study alternative policies that can stimulate productivity through technology adoption as a means of simultaneously reducing polluting and increasing output in the Economy.

[1] I have cross-checked these patterns across multiple plant-level datasets (NPRI and GHGRP for Canada, GHGRP for the U.S. and ASI for India)