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The CO_2 Emission Reduction Potential of a Carbon Tax

Carbon taxation as a policy to rein in global climate change has been a favorite of economists and anathema to politicians. It's been said that a carbon tax to reduce CO_2 emissions would establish the cost of emission reduction but leaves the amount of reduction a quantity to be discovered, while a tradable emission permit system (cap-and-trade) would nail down the emission reduction but would leave the cost to be discovered. To nudge this discussion along in a productive direction, I've looked into the power that a carbon tax might have to reduce carbon emissions.

Some published work on the U.S. electricity industry reports an estimate of the derived demand for fuel - primarily coal at the time of the study - to be around -0.09 (Jones 2016, Chapter 6 for extensive, recent journal publications). This says that a 1% increase in the price of fuel caused by a carbon tax would reduce the use of carboniferous fuel by less than one-tenth of one percent. Resources for the Future (RFF), an environmental economic research organization in Washington, D.C., has developed a carbon tax calculator for various fuels (http://www.rff.org/blog/2017/calculating-various-fuel-prices-under-carbon-tax). A $20/metric ton carbon tax would raise the average price of bituminous coal by 87%, which sounds like a lot, but with the -0.09-demand elasticity, such a carbon tax would reduce the use of bituminous by 7.8%, not a staggering amount for an 87% price increase. Using the Hicks- Marshall formula for derived demand I get estimates of the derived demand for coal between -0.25 and -0.30. Both are stronger effects than the published estimate reported above, but neither magnitude is encouraging. The largest effect on my calculations using the Hicks formula is the elasticity of demand for the final product, electricity, which also is inelastic - meaning that it doesn't fall by much when its price goes up.

Turning to the demand for electricity itself, the 87% price increase for bituminous coal would increase the price of bituminous-fired electricity by an average of about 65%. Using a range of demand elasticities averaged over residential and industrial loads between -0.15 and -0.50 yields a range of decreases in demand for electricity between 9% and 29%. The 65% price increase would be just sufficient to shift bituminous-fired generation to dispatchable gas-turbine generation and is easily sufficient to shift some bituminous-fired generation to non-dispatchable wind and solar PV generation. Altogether, focusing on the final product rather than the taxed input in electricity generation yields a more optimistic view of the effectiveness of a carbon tax, at least on coal.

The demand for gasoline and for vehicle miles traveled both respond quite inelastically to price, leaving carbon taxation of that resource and that activity with less scope for reducing carbon emissions than coal and electricity considered above. Long-run elasticities of gasoline demand have been estimated between -0.25 and -0.40, and long-run elasticities of the demand for vehicle miles traveled are in the range of -0.15 to -0.20 (Jones 2016, Chapter 8 for extensive, recent journal publications). Using RFF's carbon tax calculator, a $20/metric ton carbon tax would raise the average gasoline price in the United States by 9%. Using the demand elasticity range for gasoline cited above, a tax of this magnitude would reduce gasoline demand between 2.3% and 3.6%. A tax of $50/MT would increase the gasoline price by 22%, reducing consumption by 5.5% to 8.8%. These are not the ranges of CO_2 reductions needed to keep the increase in global mean temperature to targeted levels.

By looking at two of the largest sources of carbon emissions - electricity generation and transportation – calculations show limited scope for reduction in response to price, but of the two, emissions from electricity generation appear to respond non-negligibly to a carbon tax. More aggressive fuel mileage targets as well as alternative-fueled vehicle adoption may be more effective in the long run in reining in CO_2 emissions from transportation.

References

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