Executive summary for: Firm-level estimates of fuel substitution: an application to carbon pricing

Motivation

In light of climate change, there is an increasing global need to phase-out the use of fossil fuels, and to switch to the use of cleaner energy sources. This is true for households, for service providers and for manufacturing firms. Reflecting on the role that manufacturing firms have to play in transitioning to a cleaner economy, estimates of fuel substitution elasticities will facilitate ex-ante analyses of climate policies. The ability of manufacturing firms to switch from more- to less-polluting fuels has important impacts on the costs of achieving emission reductions both for the firms themselves and also for the wider economy. In this research we provide estimates of fuel substitution elasticities, which reveal firms' ability to switch between fuels.

We use the estimated elasticities to simulate the effectiveness of carbon taxation in encouraging firms to switch towards the use of less carbon-intensive fuels and, ultimately, in reducing CO_2 emissions. Carbon markets are becoming increasingly more prevalent around the world; according to the World Bank's most recent review of carbon markets[1], these markets are now present in all continents. Despite their growing ubiquity, to date there has been a dearth of studies analysing their effectiveness in reducing emissions. Through this research we attempt to bridge this gap in the current understanding of the effectiveness of carbon pricing at reducing CO_2 emissions.

Results and Conclusions

We use micro data on manufacturing firms operating in Ireland over the period 2004 to 2009 to analyse their abilities to switch between fuels. The firms in our dataset use three types of fuels: electricity, oil and gas. We are particularly interested in responsiveness of electricity demand to fuel price changes, as an increasingly decarbonized economy is likely to be an increasingly electrified one. We calculate total price elasticities in addition to the partial elasticities that are frequently calculated in the literature. Unlike the partial elasticities which only measure changes in the demand for individual fuels to price changes, the total elasticities adjust these individual fuel-demand changes for changes in aggregate energy demand, and for the share of each fuel in this aggregate demand. The estimated total elasticities indicate that electricity demand is highly responsive to changes in its own price, but is only weakly

[1] The World Bank, Ecofys, and Vivid Economics (2016), State and Trends of Carbon Pricing 2016.

substitutable with oil and gas. Based on the total elasticities, oil and gas are less sensitive to price changes. The high total elasticity of demand for electricity reflects the fact that the demand for aggregate energy amongst manufacturing firms in Ireland is price elastic, and that the share of electricity in total energy use is very high.

We compare the price elasticities estimated from data at the firm level to estimates from aggregating our firm panel to industry level. We confirm earlier theoretical predictions that industry-level estimates can yield vastly different results. In particular we find that elasticities based on aggregate data can vastly over-state the degree to which fuels respond to changes in their own prices and, for some fuels, to changes in the price of alternative energy sources.

Using the estimated total elasticities, we simulate the impact of a domestic carbon tax of €15/tonne CO_2 on firms operating in the Irish manufacturing sector. In our simulation, we assume that the carbon tax is not levied on firms already regulated by the European Union's Emissions Trading System (EU-ETS), or on electricity prices as these are also covered under the EU-ETS. The results show that a domestic carbon tax will have a limited impact on greenhouse gas emissions. This is largely because the carbon tax is not levied on electricity (as electricity generation is covered under the EU-ETS) which is the most important fuel source for Irish manufacturing firms. Furthermore, some of the reduction in emissions from decreased use of oil and gas is cancelled out by an increase in the use of electricity which in Ireland, as in many other countries, still has a high carbon content.

Policy implications

Our results illustrate that, when assessing the likely effectiveness of carbon pricing at encouraging firms to switch from dirty to clean fuels and, ultimately, at reducing CO_2 emissions, it is important that the correct measure of price elasticity is used. We also show that, for policymakers in European countries who are unable to influence the price of carbon under the EU-ETS, domestic carbon pricing schemes may have only a limited impact on the production of CO_2 by firms operating in the industrial sector. Relative to domestic carbon taxation, which we assume does not impact the electricity price, a rise in the price of EU ETS permits would have a much greater impact on CO_2 emissions. This reflects the fact that, across the manufacturing sector, electricity is an important fuel source with a total price elasticity that indicates, for some firms, a high degree of price sensitivity.