Green Growth Knowledge Platform (GGKP)
Third Annual Conference
Fiscal Policies and the Green Economy Transition: Generating Knowledge – Creating Impact
29-30 January, 2015
University of Venice, Venice, Italy

The net emissions effects of fuel taxes

Thomas Sterner (Gothenburg University)
Carolyn Fischer (Resources for the Future)
Jared Carbone (Colorado School of Mines)

The GGKP's Third Annual Conference is hosted in partnership with the University of Venice, The Energy and Resources Institute (TERI) and the United Nations Environment Programme (UNEP).

GREEN GROWTH
Knowledge Platform

The Net Emissions Effects of Fuel Taxes

Jared Carbone, Carolyn Fischer and Thomas Sterner[1]

Together with supply security and local pollution issues, climate change has come to be one of the dominant issues framing policy decisions in the area of transport and fuel demand. The IPCC and other reports like the Stern review have shown that to meet climate targets (like the 2ºC target) strong policy instruments will be needed. The textbook prescription builds on a uniform, international carbon price created either through taxation or cap and trade. For various reasons, such general instruments are rare and in their absence, we need to evaluate the instruments that do exist. Among the instruments with the highest effective cost of carbon are fuel taxes in the transport sector in some countries, in particular the EU and Japan. The motivation for their existence is not necessarily related to the climate; they may be implemented for fiscal reasons or possibly related to congestion and local environmental goals. The effect, however, is independent of the motivation. The level of fuel taxation in the EU is several hundred $/tCO2 as compared to a few dollars for most permit trading schemes. As such, they provide an interesting case study.

A large literature has analyzed the demand responses to fuel prices, finding them to be quite sensitive, at least in the long run. (Elasticities run in the range of -0.6 to -0.8, depending on model, country and time period.) Simple application of these values shows that absent fuel taxation, demand would have been twice as large. Even total OECD demand for transport fuel would have been 30% higher (Sterner 2007). This analysis, however, neglects a range of responses by other markets, sectors, and countries. In particular, a significant reduction in demand for oil in a large region places downward pressure on the world market price of oil, leading to increased use of oil in other countries. At the same time, changes in the relative price of oil will shift demand for other fossil fuels, like natural gas and coal, among the sectors that can choose among energy sources. These substitution effects cause further price changes, as supply and demand equilibrate across the spectrum of energy uses. Thus, a complete analysis of the effects of regional fuel taxes on global carbon emissions requires knowledge not only of demand elasticities for oil, but also supply and demand responses for all fossil fuels both in taxing and nontaxing regions.

Global trade models simulate these complex fuel market interactions, but with underlying assumptions that are not always transparent or easy to alter. This paper parses the different mechanisms of the global emissions response and illustrates them with simpler numerical calculations, easily allowing for sensitivity analysis to be informed by a range of empirical studies. Thus, we provide a bridge between studies using single sectors or countries and global trade models, and offer a plausible range of estimates of the net effect of transport fuel taxes on global emissions.

We begin with a review of the empirical literature on demand and supply elasticities for fossil fuels. Next, since most studies on carbon leakage use computable general equilibrium (CGE) models based on the Global Trade Analysis Project (GTAP), we review the main findings in those models. Most have studied international emissions leakage from carbon prices; those leakage rates tend to fall in the 10-30% range (Babiker and Rutherford 2005; Boehringer et al. 2012), depending on the carbon-regulating coalition as well as model assumptions. Importantly, the vast majority of carbon leakage arises through the channel of international energy markets, not through lost "competitiveness" in trade-sensitive energy-intensive sectors. Given the globally integrated market for oil, emissions leakage from fuel taxes is likely to be significant and perhaps larger than that of broad-based carbon taxes. A few CGE studies have delved into sensitivity analysis with respect to underlying assumptions, particularly about the supply of fossil fuels. Babiker (2005) varies assumptions about production

[1] Colorado School of Mines, Resources for the Future, and Gothenburg University. Correspondence: fischer@rff.org

and competition (e.g., returns to scale and strategic behavior) and finds a larger range of global leakage rates: 25% to 130%. Others identify the potential for cartel behavior on the part of OPEC as an important determinant for leakage, both numerically (Böhringer et al. 2014) and theoretically (Kverndokk et al. 2013).

The focus of our attention is to improve the linkages between the theory and modeling literature on carbon leakage and the empirical literature on fossil energy markets. We derive a simple model of demand and supply for the major fossil fuels (petroleum, natural gas, and coal) with global markets divided into the taxing region and the rest of the world. The model is then calibrated with supply and demand and cross-price elasticities for each fuel, as well as the market share of the regulating region. We first conduct an exercise with a standard GTAP-based CGE model to simulate energy consumption and emissions responses and derive the implicit elasticities for our calibration. We then compare these to empirical estimates from the literature (e.g., Serletis et al. 2010). We begin with two policy scenarios: 1) suppose the EU did away with its elevated transportation fuel taxes (roughly cutting prices in half), and 2) suppose the US imposed EU-style transportation fuel taxes (roughly doubling prices).

We find that the differences in parameterization make big differences in results. We calculate the leakage rate relative to the emissions change that would result from the direct response of reductions in domestic oil consumption due to the tax (i.e., as would be predicted by a partial equilibrium model). We find leakage rates from petroleum tax changes range from 17% to 57%. Leakage rates from other fuels range from 2% to 50%. Leakage to foreign consumers ranges from 7% to 34%. In particular, we find that using the elasticities implicit in the GTAP model leads to large emissions changes, low leakage rates overall, and little change from other fuels. By contrast, the Serletis et al. estimates indicate more inelastic demand, particularly in the U.S., but also a higher cross-price elasticity between oil and gas in the U.S. Supply elasticity estimates also indicate less responsiveness to oil price changes, while gas and coal are more elastic, compared to GTAP. In this case, overall emissions changes become much smaller, while leakage rates are larger. Using the U.S. elasticity estimates, much of the leakage comes from other fuels, while a calibration to U.K. elasticities finds most leakage from changes in foreign oil consumption.

We continue to conduct more specific sensitivity analysis to identify the most important drivers for understanding the global emissions response to transportation fuel taxes. This will help guide empirical researchers as to what estimates are most useful to refine. Given that certain policies can also influence supply and particularly demand elasticities (such as via fuel economy policies), we can consider the complementarity of such climate policies for the emissions impacts of fuel taxes. The analysis can also consider the potential range of impacts from removing fossil fuel subsidies, a current international priority (IMF 2013).

References

Babiker, M.H. 2005. Climate Change Policy, Market Structure, and Carbon Leakage. Journal of International Economics 65(2): 421–45.

Babiker, M.H., and T.F. Rutherford. 2005. The Economic Effects of Border Measures in Subglobal Climate Agreements. The Energy Journal 26(4): 99–126.

Böhringer, C., K.E. Rosendahl and J. Schneider (2014): Unilateral Climate Policy: Can OPEC Resolve the Leakage Problem? The Energy Journal 35 (4), 79-100.

Böhringer, C., Carbone, J.C., Rutherford, T.F., 2012. Unilateral climate policy design: efficiency and equity implications of alternative instruments to reduce carbon leakage. Energy Econ. 34 (S2), S208–S217

IMF. 2013. Energy subsidy reform: Lessons and implications. Washington, DC: International Monetary Fund.

Kverndokk, S. and K.E. Rosendahl (2013): The Effects of Transport Regulation on the Oil Market. Does Market Power Matter? Scandinavian Journal of Economics. 115(3), 662–694.

Serletis, A, G Timilsina & O Vasetsky 2010. Interfuel Substitution in the United States. Energy Econ. 32: 737-45.

Sterner, T. (2007), Fuel Taxes: An Important Instrument for Climate Policy, Energy Policy 35, 3194–3202.