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Carbon leakage from unilateral Environmental Tax Reforms in Europe, 1995–2005

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Abstract

Studies of the effects of the Kyoto Protocol have shown carbon leakage (typically from tax and permit schemes with lump-sum revenues recycling) to be in the range of 5–20% using static Computable General Equilibrium models. However, in practice, researchers have found that carbon leakage from the implementation of the EU ETS is unlikely to be substantial because transport costs, local market conditions, product variety and incomplete information all tend to favour local production. This study investigates potential carbon leakage from six EU Member States (MSs) that implemented Environmental Tax Reform (ETRs) unilaterally over the period 1995–2005. The study uses the large-scale multisectoral integrated energy–environment–economy (E3) model of 27 European countries, energy–environment–economy model of Europe (E3ME), to undertake a dynamic comparative analysis to assess any carbon leakage effects over the longer term 1995–2012. A counterfactual Reference case is constructed, assuming that the six countries did not introduce ETRs; then alternative scenarios are developed to assess the effects of the ETRs, including effects on CO_2 emissions for the EU25 economies. Most MSs recorded a reduction in CO_2 emissions when comparing the Baseline case to the Reference case. The results show that carbon leakage is very small and in some cases negative, due to technological spillover effects.

Keywords: Carbon leakage; Environmental Tax Reform; Tax policies

1. Introduction

Carbon leakage is one measure of the effectiveness of unilateral policies to reduce CO_2 emissions. Carbon leakage is measured by taking the increase in CO_2 emissions outside the country or region taking domestic mitigation action and then dividing by the reduction in the emissions of the country or region. It is an important measure because there are concerns about the effectiveness of unilateral action, either by one country acting alone in an Environmental Tax Reform (ETR) or in the EU acting as a bloc, when there is potential for carbon-intensive production to migrate outside the country or region taking action.

Most of the literature on carbon leakage is about prospective leakage from policies which are being considered or which are just coming into force, nearly always using Computable General Equilibrium (CGE) models based on 1 year's data, with a very stylized treatment of the dynamics of policy effects. Such analysis is *ex ante* in that it concerns future effects, so that there is no immediate check against actual outcomes. Our study develops the literature in that it assesses potential leakage from historical actions and uses an econometric dynamic model, i.e., it is an *ex post* analysis of actual carbon policies as components of tax reforms. It is also one of the few studies to assess carbon

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leakage when revenues from policies are explicitly recycled by governments into reducing other taxes or raising government expenditure, rather than being neutralized by being returned (lump-sum) to consumers. We have studied six examples of ETRs in Europe over the period since 1994, using Cambridge Econometrics' energy–environment–economy model of Europe (E3ME)[2] and developed a series of scenarios to assess the nature and extent of carbon leakage, both short- and long-term annually, to the year 2012 with a variety of recycling schemes.[3]

Section 2 of the paper provides a brief review of the literature on carbon leakage, which is dominated by debates arising from CGE modelling. Section 3 describes the approach taken here to modelling the effects. Section 4 describes the policies incorporated into this modelling and the scenarios used. Section 5 describes the results, including the overall impacts of ETR policies on economic activity and CO_2 emissions, and the sources and magnitude of carbon leakage effects. Section 6 provides some conclusions.

2. The literature on carbon leakage

The IPCC's *Second Assessment Report* (1996) found a high range of variation in leakage rates from world models for OECD action, going from close-to-zero to 70%. The Third Assessment Report (TAR) (IPCC, 2001) found that the range had narrowed to 5–20% but noted that these estimates come from models with similar treatment and assumptions. It also noted that the narrower range does not necessarily reflect more widespread agreement. The TAR found that international permit trading substantially reduces leakage. The TAR also considered spillover through the improvement in performance or reduction in cost of low-carbon technologies.

Over the last few years, the literature has extended the earlier analysis using equilibrium models to include effects of trade liberalization and increasing returns in energy-intensive industries, and a new empirical literature has emerged.

2.1. Equilibrium modelling of carbon leakage from the 1997 Kyoto proposal

Gerlagh and Kuik (2006) provide a review of the estimated leakage rates in the CGE literature and a meta-analysis explaining the effects of assumptions in the models on the results. Here we focus on some significant studies.

Paltsev (2001) uses a static global equilibrium model GTAP-EG based on 1995 data to analyse the effects of the 1997 proposed Kyoto Protocol. He reports a leakage rate of 10.5%, within a sensitivity range of 5–15% covering different assumptions about aggregation, trade elasticities and capital mobility, but his main purpose is to trace back non-Annex B increases in CO_2 to their sources in the regions and sectors of Annex B. The chemicals and iron & steel sectors contribute the most (20% and 16%, respectively), with the EU being the largest regional source (41% of total leakage). The highest bilateral leakage is from the EU to China (over 10% of the total).

Kuik and Gerlagh (2003) using the similar GTAP-E model conclude that for Annex I Kyoto-style action 'carbon leakage is modest, confirming an extensive set of earlier studies'. They find that the major reason for the leakage is the reduction in world energy prices, rather than substitution within Annex I. They find that the central estimate of 11% leakage is sensitive to assumptions about trade-substitution elasticities and fossil-fuel supply elasticities and to lower import tariffs under the Uruguay Round. These sensitivities result in a range of 6–17% leakage. In a more recent application (Gerlagh and Kuik, 2006), the model is extended to include technological spillovers and the leakage rates are much reduced, even becoming negative under some assumptions.

In contrast to this consensus of global leakage for Kyoto-style action of about 10%, Babiker's (2005) paper presents findings that extend those reported in the SAR and the TAR. He extends a seven-region, seven-good and three-industry global CGE model (similar to the other GTAP models except for the energy-intensive sector and the earlier 1992 database). The distinctive extension is the inclusion of a treatment of increasing returns to scale (IRTS) and strategic behaviour in the energy-intensive industry. Assuming the adoption of the Kyoto Protocol by the OECD region, he presents four leakage rates, which depend on the assumptions adopted:

1. 20% for constant returns to scale and differentiated products (the Armington assumption),
2. 25% for IRTS and differentiated products,
3. 60% for constant returns and homogeneous goods (HG),
4. 130% for the HG–IRTS combination.

The main reason for the higher estimates is the inclusion of a treatment of IRTS and strategic behaviour in the energy-intensive industry. The 130% rate implies that OECD action leads to more global GHG emissions rather than less.

2.2. Assessing very high rates of carbon leakage

In assessing this high leakage finding, it is important to understand the critical underlying assumptions.

1. The CGE model assumes a global social planner to maximize welfare, full information over space and time,

[2]For more details the reader should refer to the model website www.e3me.com and the online manual www.camecon-e3memanual.com/cgi-bin/EPW_CGI.

[3]The modelling of ETR was done in the context of a EU FP6 Integrated Project COMETR (Sixth framework Section 8.1 Policy Oriented Research STREP 3.1) Task 5 Competitiveness effects of Environmental Tax Reforms, coordinated by Mikael Skou Andersen, NERI, University of Aarhus, Denmark. See www2.dmu.dk/cometr/