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Journal of International Economics 65 (2005) 421–445

Journal of INTERNATIONAL ECONOMICS

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Climate change policy, market structure, and carbon leakage

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Received 19 February 1999; received in revised form 27 July 2003; accepted 29 January 2004

Abstract

The 1997 Kyoto Protocol on climate change obliges the industrialized countries to initiate the international effort of abating anthropogenic greenhouse gas (GHG) emissions. If such an initiative is to be taken, the associated competitive effects may lead to significant relocation of developed countries' energy-intensive production. This paper examines this issue. I adopt an oligopolistic structure combined with increasing returns to scale production technologies to represent the strategic interaction among the firms producing energy-intensive products. This representation is then embedded within a multi-regional computable general equilibrium model, which in turn is used for quantifying these relocational effects. The results suggest that significant relocation of energy-intensive industries away from the OECD may occur, depending on the type of market structure, with leakage rates as high as 130%, in which case GHG control policies in the industrialized countries actually lead to higher global emissions.

Keywords: CGE model; Leakage; Energy-intensive; Market structure; Oligopoly

JEL classification: C6; D4; F1; L1

1. Introduction

The 1997 Kyoto Protocol obliges developed industrial countries to initiate an international effort to abate anthropogenic greenhouse gas (GHG) emissions (Conference

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0022-1996/$ - see front matter © 2004 Published by Elsevier B.V.
doi:10.1016/j.jinteco.2004.01.003

of the Parties to the United Nations Framework Convention on Climate Change, 1998).[1] As only one part of the world would constrain its emissions under this agreement, many concerns are raised about the agreement's effects on trade and the location of industrial production. One particular effect is that the associated competitive effects may lead to significant offsetting emissions increases in the countries without controls—a phenomenon typically referred to in the literature as carbon leakage.[2] The leakage process may occur through two different but related channels. First, the lower world prices of energy (reduced demand in the constrained economies exerts a downward pressure on energy prices) encourage substitution towards energy in countries without a carbon constraint. Second, energy-intensive industry may relocate from countries with carbon controls to those without, and export its energy-intensive products back to the constrained countries. The existing results on production effects and leakage from a carbon policy in industrialized countries are mainly derived from computable general equilibrium (CGE) models.[3] Though these models treat the first channel relatively well, they fall short of adequately representing the industry relocation channel. For example, some of these models do not even have a separate representation of production and trade in energy-intensive products, whereas others, which include such a representation, suffer from at least three maintained assumptions: constant returns to scale (CRTS) technologies, perfect competition, and an Armington structure characterizing trade in energy-intensive products.[4] Given the restrictive nature of the modeling assumptions, the scope for leakage tends to be quite limited in these models.[5] This paper addresses these shortcomings by exploring more fully the effects of the market structure on the geographic distribution of energy-intensive production, trade, and leakage. In doing so, the paper captures two sources that may contribute significantly to the offshore production and leakage effect: the pro-competitive effect of carbon abatement policies in an initially monopolized industry, and the effect of entry and exit of firms in such an industry. These effects are captured by explicitly modelling the strategic interaction among firms producing energy-intensive products through spatial Cournot oligopolies with free entry and exit[6] in a seven-commodity seven-region applied general equilibrium model of the world economy. With this richer

[1] In the Kyoto Protocol the OECD as defined in 1990, the economies of the Former Soviet Union and the East European economies in transition agreed to take on reduction commitments of a level on average about 5% below their 1990 greenhouse gas emissions levels. The list of these countries was included in Annex B of the Kyoto Protocol and are therefore often referred to as "Annex B countries".

[2] Under subglobal abatement, the carbon leakage rate in a non-abating region is defined as the change in its emissions as a fraction of the emissions reduction by the abating regions. The global leakage rate is, then, simply the sum of the regional leakage rates.

[3] Examples are Babiker et al. (1997), Felder and Rutherford (1993), and OECD (1992). For a brief survey of CGE models used to study the economic effects of climate change (including leakage) see Gaskin and Weyant (1993) and Weyant (1999).

[4] It is well recognized that energy-intensive industries such as iron and steel, chemical products, paper and pulp are characterized by economies of scale and market power (Markusen et al., 1993).

[5] The estimates of leakage reported in these studies range between 6% and 25%.

[6] Spatial competition in Cournot oligopolies has been used extensively in the IO and the International trade literature for modeling firm location and in studying market structures (e.g. Greenhut and Greenhut, 1975; Brander, 1981; Markusen, 1981; Brander and Krugman, 1983; Venables, 1985; Markusen and Venables, 1988).