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Evaluating the carbon leakage effect on cement sector under different climate policies

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ABSTRACT

The European-Union Emissions Trading System (EU-ETS) is a cap and trade scheme that requires the industries participating in the program to obtain allowances to cover their carbon emissions. Energy Intensive Industries claim that this system puts their European plants at an economics disadvantage compared to facilities located outside the EU. As a direct consequence, industries may relocate their production activities in unregulated countries, leading to the so-called carbon leakage effect. In order to curb this effect, several policies have been devised, including grandfathering of CO_2 allowances and border tax adjustment. This paper investigates the impact of these two policies on the cement sector, with a particular focus on the Italian market, particularly prone to carbon leakage. The analysis is based on an oligopolistic partial equilibrium model with a detailed technological representation of the market. The model is a Generalized Nash Equilibrium Problem that accounts for the interactions of cement companies. Simulations show that neither the grandfathering nor the border tax adjustment fully solve the carbon leakage problem because cement companies modify their cement and clinker trade strategies according to the measure applied in order to avoid or reduce their carbon costs.

1. Introduction

Total greenhouse gas (GHG) emissions have continued to increase over 1970 to 2010 with larger absolute increases between 2000 and 2010, despite a growing number of climate change mitigation policies. Since 1970, cumulative CO_2 emissions from fossil fuel combustion, cement production and flaring have tripled, and cumulative CO_2 emissions from forestry and other land use have increased by about 40%.

It has been proved by Fujii and Managi (2013) that CO_2 emissions are strictly related to economic growth in upstream industries and differ among different industries. They found that under the current environmental policy and economic system in OECD countries, the paper, wood and construction industries reduce CO_2 emissions with increasing economic growth.

In 2011, annual CO_2 emissions from fossil fuel combustion, cement production and flaring were 34.8 ± 2.9 $GtCO_2$/yr. Emissions of CO_2 from fossil fuel combustion and industrial processes contributed about 78% of the total GHG emissions increase from 1970 to 2010, with a similar percentage contribution for the increase during the period 2000 to 2010 (see IPCC, 2014 for a detailed analysis).

The climate change problem, which is now well-known at worldwide level, has been fully formalized in the Kyoto Protocol and Europe has agreed to it by implementing the European-Union European Emissions Trading System (EU-ETS) in 2005. By 2020, EU will try to achieve the "20-20-20" targets, namely reduction in CO_2 emissions, development of renewable energy sources, and increase of energy efficiency. These targets represent the first steps towards a complete decarbonization of the energy systems and an abatement of around 80% of CO_2 emissions compared to the 1990 level (Energy Roadmap 2050).

The EU-ETS is a cap and trade system that limits CO_2 emissions generated by power and specific industrial installations. This CO_2 regulation causes additional costs for the Energy Intensive Industries (EIIs) operating these installations. These additional costs may affect EIIs' competitiveness on international markets and the effect may be relevant for some particular sectors (see Droege, 2012). As a consequence, EIIs are threatening to relocate part of their activities in countries where environmental regulations are not applied or are less restrictive for protecting their competitiveness. The relocation of production activities would imply a

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transfer of CO_2 emissions as well, leading to the so-called “carbon-leakage” phenomenon. The sectors that are exposed to carbon leakage generally consist of multinational companies operating worldwide. These companies hence could relocate part of their production without suffering dramatic economic losses themselves. This is especially the case of metals and cement industries. European cement industries have been amongst the most important supporters of the competitiveness and carbon leakage debate.

1.1. Related literature

A growing body of academic literature has been developed in recent years to address the problem of carbon leakage in industrial sectors and to find the best policy measures to counteract it. These include *free allowance allocation (FA)* and *border tax adjustment (BTA)*. The first remedy was imposed by Directive 2003/87/EC for the period 2005–2012. Allowance grandfathering to those EIIs “exposed to a significant risk of carbon leakage” became matter of discussion during the period of settlement of the third ETS phase (2013–2020). The need to protect the competitive position of the EU industry has accordingly been taken into account in the design of the Directive 2009/29/EC regulating the third ETS phase.[1] The European Commission has issued a list of all sectors that are deemed to be subject to the risk of carbon leakage and cement sector is one of them.[2] The application of the *BTA* policy aims at mitigating the carbon leakage effect by supporting EU EIIs' exports and taxing their imports from countries with a more lenient (or no) environmental system.[3] Note that this policy is applied in addition to the free allowance allocation.

To address the impact of these environmental measures, many research fields have been explored: econometrical studies, index decomposition analysis, and analytical models.

Ex post econometrical studies have not revealed so far any evidence of carbon leakage (see, for instance, Ellerman et al., 2010; Reinaud, 2008). However, a meta-regression analysis is conducted by Branger and Quirion (2014) to estimate the impact of border carbon adjustment policies under different assumptions on the leakage estimates (varying from 5% to 25%).

Index decomposition analysis has been also widely used in studies dealing with energy consumption since the 1980s and carbon emissions since the 1990s.

The study by Xu et al. (2012) focuses on the cement industry in China. They give a decomposition per kiln type, allowing the energy efficiency effect to be separated into a structural effect (change of kiln type) and a kiln efficiency effect. However, they do not consider clinker trade in their decomposition, which is arguably of little importance for China, but matters for Europe. With this aim, Branger and Quirion (2015) by using a LMDI decomposition approach are able to estimate that the introduction of the EU-ETS brought small but positive technological abatement and European cement industry gained over-allocation profits, mostly due to the slowdown of cement production.

Concerning the determinants of carbon leakage, several studies, mostly based on analytical models like general equilibrium models or optimization problems (Boston Consulting Group, 2008a; Demailly and Quirion, 2008; Linares and Santamaria, 2012; Ponssard and Walker, 2008; Reinaud, 2008, 2009) show that the carbon leakage effect in the cement sector depends on the location of the plants and on transportation costs. Cement and clinker trade is characterized by high land (road and rail) transportation costs. Ship transport is much cheaper and its economic efficiency increases with the distance. For this reason, coastal plants (and countries) have a higher incentive to relocate their clinker/cement production than inland plants. This implies that the geographical distribution of EU plants affects relocation strategies.

1.2. Methodology and contributions

In this paper, we analyze whether the application of the *FA* and *BTA* policies can mitigate carbon leakage and the loss of competitiveness of cement sector. In addition we aim at investigating which policy is more effective in tackling carbon leakage.

Fixed free allocation may not deter operational leakage if plants can economically reduce output in favor of imports. If a plant can generate higher returns by selling their freely-allocated allowances instead of their core product, they may choose to decrease production (within limits to avoid closure rules) and sell their allowances instead (see Carbon Trust, 2010).

The broad debate on border adjustments encompasses a wide range of proposals, some of which have potential to be discriminating, punitive, or protectionist.

To address these issues we develop an international spatial oligopolistic model based on a technological representation of the cement market that describes clinker and cement production processes in different world countries with a particular focus on the Italian market. We assume that companies are Cournot players that maximize their profit simultaneously, since their strategies are interrelated by the market clearing conditions, common to all the companies (for the oligopolistic assumption see also Meunier and Ponssard, 2014; Demailly and Quirion, 2008). We measure their carbon leakage exposure by monitoring their cement and clinker exchanges between environmentally regulated and unregulated areas. From the mathematical point of view, the problem belongs to the class of Generalized Nash Equilibrium Problem (GNEP).[4] GNEPs have been widely used to address competitiveness and to evaluate the different impact of environmental policies in incomplete markets with application to the electricity market (see for a detailed description Gabriel et al., 2012, for applications to the electricity market see Smeers, 2003a,b). The model is reformulated as a Mixed Complementarity Problem (MCP)[5] and implemented in GAMS using the PATH solver.

To our knowledge it is the first time that a so detailed description of the cement market model has been introduced. Our model takes into account several issues (different technologies in clinker and cement production, geographical distribution of plants, regulated and unregulated areas, different environmental policies, endogenous clinker and cement demand) in a unified framework, while the recent literature usually threats them separately.

[1] Specifically, point 12 of Article 10a states that “*in 2013 and in each subsequent year up to 2020, installations in sectors or subsectors which are exposed to a significant risk of carbon leakage shall be allocated, pursuant to paragraph 1, allowances free of charge at 100|% of the quantity determined in accordance with the measures referred to in paragraph 1*” See: http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0063:0087:en:PDF.

[2] The first carbon leakage list (available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:001:0010:0018:EN:PDF) was adopted by the European Commission at the end of 2009 and is applicable for the free allocation of allowances in 2013 and 2014. It has to be updated every five years. The Commission will determine the next list by the end of 2014, which will apply for the years 2015–2019.

[3] See Monjon and Quirion (2010) and references therein and Cook (2011b) for a comprehensive discussion on BTA applied to the cement sector.

[4] See Facchinei and Kanzow (2007) and Pang and Fukushima (2005) for more details on GNEP and its possible applications.

[5] See Facchinei and Pang (2003).