Energy Policy 117 (2018) 434–444

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Policy stringency under the European Union Emission trading system and its impact on technological change in the energy sector☆

Germà Bel*, Stephan Joseph

Universitat de Barcelona & GiM-IREA, Spain

ARTICLE INFO

JEL Codes:
Q55
Q58
O33
O38

Keywords:
Environmental policy
Emission trading system
Policy stringency
Technological change
Patent count data
Energy sector

ABSTRACT

In this study, we use patent count data for overall Climate Change Mitigation Technologies, and for those related to energy production and distribution to evaluate the relationship between the sizable oversupply of European Union emissions Allowances and a policy shift marked by the transition from Phase I to Phase II under the European Union Emission Trading System, on the one hand, and on "green" patenting, on the other. According to our results, the expected negative impact of this oversupply on technological change seems to be confirmed. Thus, stakeholders take the actual supply of certificates into account when determining their innovative activity. In the same vein, they do so with respect to policy changes related to greater stringency, which generated a sizeable increase in patenting activity when controlling for other economic factors. Our results suggest that a critical evaluation of emission caps and allowances distribution must be undertaken.

1. Introduction

Technological change aimed at mitigating the impact of economic activity on climate change is a powerful tool for moving towards a low-carbon economy. To strike out on this path, various policies have been adopted worldwide. One of these is the European Union Emission Trading System (EU ETS) which, as a market-based regulation, established the first and largest market for greenhouse gas (GHG) emissions allowing installations in the system to cut their emissions in a flexible and cost-efficient way. However, external shocks and a lack of stringency have led to the creation of a sizeable oversupply of allowances in the market, potentially hampering the effect of the policy on low-carbon technological change (Sandbag, 2013).

Against this backdrop, the first goal of our study is to determine empirically whether this oversupply of allowances in the market has a negative effect on the outcome of the creative process in countries covered by the policy. Secondly, we examine how policy changes introducing greater stringency affect innovative behavior.[1] To this end, we use a count data model to estimate the impact of certificate oversupply on climate change mitigation technologies (CCMTs) in the energy sector. We focus on this sector because it is the most productive in terms of CCMT patenting, and we provide information on the selection of this patent variable in Table A1 (and include details explaining the Y02 class). Furthermore, because a policy shift occurred in 2008, we use a binary variable (described in section IV) to evaluate the impact of this shift, which is arguably an additional effect to that of increased stringency, for the period 2008–2012.

With this study we seek to contribute to the literature by analyzing how innovation responds, on the one hand, to lax policies and, on the other, to more stringent guidelines. We take the specific case of the EU ETS and measure stringency in terms of the number of excess permits in the market. We expect a less stringent EU ETS to result in a large oversupply of permits, whereas measures that increase the stringency of the trading system are expected to reduce this oversupply. As stated above, we focus our attention on technologies that seek to reduce the GHG emissions related to energy generation, transmission and distribution. To the best of our knowledge, this is the first multivariate empirical analysis to fully consider the first two phases of this policy (2005–2007 and 2008–2012). As such, this study specifically fills the gap in the literature examining the EU ETS and more broadly the gap in the literature concerned with any cap-and-trade regulation. Finally, we hope to broaden understanding of the way in which policy failures influence innovative behavior in the framework of such policies.

We organize the rest of the study as follows. First, we provide a brief

☆ *This article is part of a Virtual Special Issue entitled 'Economic Analysis of Recent Energy Challenges: Technologies, Markets and Policies'*

* Correspondence to: Dep. of Econometrics, Statistics and Applied Economics, Universitat de Barcelona, John Keynes 1-11, 08034 Barcelona, Spain.
E-mail address: gbel@ub.edu (G. Bel).

[1] Performance evaluations of public policies previously implemented can help improve and modify existing policies (Guimarães et al., 2010).

https://doi.org/10.1016/j.enpol.2018.03.041
Received 6 June 2017; Received in revised form 14 February 2018; Accepted 15 March 2018

outline of the EU ETS and its different phases and we review the literature. In Section 3, we describe the structure of the data and the variables used in the empirical exercise. Next, we present the methodology and the regression outcomes, the implications of which are then discussed in relation to the research questions posed. Finally, we draw our main conclusions and highlight policy measures that might put the EU ETS on the right track.

2. Description & aims of the policy

In 2005 the EU ETS came into operation. The trading system can be considered the European Commission's (EC) main policy for reaching its ambitious GHG reduction targets under the 2030 framework for climate and energy policies. To date, the 28 EU Member States, as well as three additional member states of the European Economic Area (EEA: Iceland, Liechtenstein, and Norway) have joined the system, making it the world's largest carbon market. The main principle of the EU ETS can be summed up quite simply as "cap and trade". The first step in the system – "cap" – sees the EC set an EU-wide ceiling for GHG emissions under the policy, which is gradually reduced every monitoring period. The GHG ceiling is fixed in such a way that the EC issues so-called EU emission allowances (EUAs). These represent the right of a holder of such a certificate to emit one ton of CO_2, or an equivalent amount of GHG with respect to its climate impact, as listed in Annex II of the EC Directive 2003/87/EC (European Commission, 2013).

Hence, to reduce the EU ETS cap the EC cuts the overall number of EUAs in the market. Firms subject to this policy must cover their emissions by allowances; otherwise, they face heavy fines for every ton of CO_2 emission not covered. The second step – "trade", on the other hand, permits firms in the case of a shortage of allowances to purchase additional EUAs in a common market and, so, avoid penalization for non-compliance.[2] The principle underpinning the EU ETS is market-based regulation that aims to leave the means of compliance in the hands of the firms.

Currently, 11,500 installations are subject to the policy (Schmalensee and Stavins, 2017), accounting for around 45% of total GHG emissions in the participating countries. The policy only covers heavy-emitting sectors[3]; this includes many manufacturing industries[4] and the power generation sector. The latter is responsible for the lion's share of GHG emissions, accounting for 29% of total GHG emission from the EU 27 (European Environmental Agency, 2012).

The EU ETS has been implemented in three phases, each marked by fundamental changes in policy design. The first phase (2005–07) can be considered a trial phase adhering to a "learning by doing" credo. Given that prior to 2005 no reliable emission data for the sectors in the new system were available, the main task was to build an EU-wide data base for GHG emissions for the participating members. Precisely due to this lack of emission data, the first phase was marked by a certificate oversupply that led to EUAs being priced at zero from mid-2006 on.[5] The default distribution method for the EUAs was that of free allocation in accordance with the national allocation plans. With the second phase (2008–12), the EC sought to improve the EU ETS by cutting total allowances by around 6.5% compared to the 2005 level. To counter further price corrosion, the EUAs from the first phase were not bankable into the second period, while several participants started to auction off some of their allowances as opposed to just giving them away. These actions served to strengthen the policy in its aim to cut further GHG emissions.

However, the start of the second trading period coincided with the onset of the global economic crisis (2008/09) which had a marked impact on production levels and, hence, on GHG emissions in the participating countries. For this motive, installations in the system reduced their emissions by a sizeable volume because of the economic recession, rather than their abatement efforts (Bel and Joseph, 2015). This in turn led to a build-up of a considerable oversupply of allowances in the market, a problem that was exacerbated by the fact that during this second trading phase firms could cover part of their emissions by Kyoto-offsets (KOs).[6] Overall, the stringency of the policy was greatly compromised.[7]

The EU ETS is currently in its third phase (2013–2020). A major change with respect to the earlier phases is the introduction of a cap that is reduced each year by 1.74% in an attempt at reaching the emission abatement target of 21% of the 2005 level by 2020. Likewise, the default method for allocating allowances has gradually shifted from a free-of-charge distribution to that of auctioning. The EC has also implemented the "back-loading" of additional allowances, thus postponing the auctioning of 900 million EUAs until 2019–2020. This resulted in a reduction of 400 million allowances in 2014, 300 million in 2015, and 200 million in 2016 (European Commission, 2014).

3. Induced technological change and the EU ETS

The main drivers of emission abatement under the EU ETS were, and continue to be, fuel switching and the impact of the global recession that hit the EU in 2008/09. Fuel switching has proved to be a valid tool for cutting emissions in a cost-efficient manner, especially in the power generation sector (Delarue et al., 2008). But, as Calel and Dechezleprêtre (2016) point out, fuel switching alone cannot provide sufficient emission abatement to meet the ambitious EU target of an 80–95% reduction in 1990 GHG emission levels by 2050. For this reason, the EC emphasizes "the Emissions Trading System is the principal driver of the deployment of new technology, by putting a price on carbon emissions, and so stimulating the development of technologies which avoid them" (European Commission, 2015). The idea underpinning this statement is the hypothesis known as "induced innovation", which was first proposed by Hicks (1932) and later reformulated in terms of environmental regulation by Porter (1991) and Porter and van der Linde (1995), where it is known as the Porter hypothesis (PH). One version of this hypothesis states that well-designed environmental policies can foster "green" innovations.[8]

3.1. Market-based regulations and its innovation impact

Many papers since then have sought to validate, both empirically and theoretically, whether environmental regulation de facto spurs environmental innovation.[9] Few, however, focused on market-based regulations such as the EU ETS. Popp (2003) analyzed the innovation

[2] Furthermore, EU ETS companies can cover some of their emissions using international offsets ("Kyoto-offsets" – KO), stemming from Clean Development Mechanism or Joint Implementation projects.

[3] From 2012 on, aviation has also been covered by the EU ETS, so that all the participating countries' flights (within, outgoing, and incoming) are subject to the policy.

[4] Manufacturing sectors covered by the EU ETS are oil refineries, steel works and producers of iron, aluminum, metals, cements, lime, glass, ceramics, pulps, cardboards, acids, and bulk organic chemicals.

[5] Nonetheless, Ellerman and Buchner (2008) found a significant impact of the EU ETS first phase on CO2 emission abatement.

[6] See, for instance, Gronwald and Hintermann (2016), Hintermann et al., (2016, p. 118).

[7] Given that the main principle underpinning the EU ETS is that of 'cap and trade' and the capping is achieved through the allocation of emission allowances, the overall number of allowances on the market determines the degree of stringency of the policy. Brunel and Levinson (2016) review various methods for measuring stringency measures, and Sauter (2014) analyzes methods for measuring environmental policy stringency. More specifically, Koźluk (2014) discusses environmental policy instruments as a measure of policy stringency.

[8] This is typically referred to as the "weak" version of the PH. The remaining versions identified by Jaffe and Palmer (1997) are the "narrow" and the "strong" version of the PH.

[9] As our paper uses an empirical approach and focuses on the EU ETS, a market-based regulation, only papers analyzing such policies empirically are presented here. A more detailed overview of current literature in the field, however, can be found in Ambec et al. (2013). In addition, it is worth noting recent interesting developments in the study of factors that trigger innovation in the energy sector, which report a significant positive effect of path dependency, particularly for renewable energy technologies (see Rexhäuser and Löschel, 2002).