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Using output-based allocations to manage volatility and leakage in pollution markets☆

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ABSTRACT

Output-based allocations (OBAs) are typically used in emission trading systems (ETS) with a fixed cap to mitigate leakage in sectors at risk. Recent work has shown they may also be welfare enhancing in markets subject to supply and demand shocks by introducing some flexibility in the total cap, resulting in a carbon price closer to marginal damage. We extend previous work to simultaneously include both leakage and volatility. We study how OBA permits can be implemented under an overall cap that may change with the level of production in contrast with a design that deducts OBA permits from the overall permit allocation as is the current practice in the EU-ETS and California. We show that introducing OBA permits while keeping the overall cap fixed would only increase price fluctuations and induce severe welfare losses to non-OBA sectors.

1. Introduction

This paper is motivated by two critical issues in the design and implementation of emission trading systems (ETS), namely, that permit prices are rather often away from the level they were expected to be at the time the regulation was set (presumably the expected marginal benefit of pollution abatement for a given reference scenario) and how to allocate permits to firms. We analyze the interaction of these two issues. In the EU-ETS, for instance, a fraction of permits is allocated through auctions while the remaining fraction is allocated for free to firms in industries that are likely to face international competition from unregulated source such as in cement, petrochemicals, and steel. These free permits are typically allocated according to actual output based on some benchmark pollution intensity.[1]

These output-based free allocations (OBAs) are intended to solve the so-called "carbon leakage" problem, i.e., that the reduction of home carbon emissions is partly offset by a rise in foreign emissions. An OBA scheme, by subsidizing home production, reduces unregulated foreign production. There is an extensive economic literature exploring the benefit and cost of using OBAs for dealing with carbon leakage, see, for example Fischer and Fox (2007, 2012), Quirion (2009), Monjon and Quirion (2011), and Meunier et al. (2014). They appear as good second best solutions in the absence of border tax adjustments.[2]

The use of OBA schemes, however, raises another important question in the design of permit markets that are subject to demand and supply shocks, which is whether the total cap should be kept

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1 For a detailed description and empirical analysis of the EU-ETS allocation rules see Branger et al. (2015).

2 In the US carbon leakage is likely to arise in the electricity sector because of electricity trade with neighboring states or uncovered plants. The use of OBA to mitigate leakage has been studied notably by Bushnell and Chen (2012) and Burtraw et al. (2016) in those cases.

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fixed or flexible. In the EU-ETS and in California the cap is fixed (presumably for political reasons) and any difference between anticipated and actual permits going to OBA sectors are offset with deductions/additions of auction permits.

It would be perfectly feasible to introduce some flexibility in the total cap, in the spirit of the hybrid design of Roberts and Spence (1976), in which additional permits are either issued or bought back by the government at certain pre-specified prices.[3] The advantages of flexibility of the total cap is notably discussed in the intensity standard literature. With an intensity standard (also known as intensity target) the cap of emissions for a given country is indexed to its gross domestic product. They have been mostly introduced in the context of international negotiations on climate change following the Kyoto protocol. Such commitments appeared more acceptable for emerging countries (Dudek and Golub, 2003). The relevance of intensity standards has also been studied for developed economies. Ellerman and Wing (2003) develop a model to compare a fixed cap and an intensity target for Germany. Their analysis demonstrate that, due to the 2010 recession, an intensity standard (and thus a flexible cap) would have led to a more stringent carbon regulation, reflected in a higher carbon price closer to the social cost of carbon. Under uncertainty, a indexation of the cap on GDP can improve welfare by ensuring that emissions are high when they are more valuable (high marginal abatement cost) and vice-versa.[4]

The contribution of this paper is to combine the two ingredients mentioned above: carbon leakage and uncertainty, and study the performance of OBA schemes in that case. We further investigate the benefits associated with the flexibility of the cap. We built on a recent paper of ours (Meunier et al., forthcoming) in which it is demonstrated that, even in absence of leakage, there are good reasons, due to the induced flexible cap, to introduce OBA for sectors subject to large demand and supply shocks. The optimal OBA rate trades-off the benefits from flexibility with inefficiency associated to production subsidy.

In this paper we firstly generalize our previous results when leakage is also present. Without uncertainty the OBA rate should be equal to the leakage rate. This is no longer true under uncertainty because of the potential benefits of indexing the cap to the production of highly uncertain sectors. The larger the sector uncertainty, the higher the OBA rate for this sector should be. As a matter of fact, a large sector uncertainty should be considered as a factor as important as leakage for introducing OBA in that sector. This is an important and timely policy consideration since regulators are currently reviewing the allocation of free allocations in the EU-ETS for the period 2020–2030.

Secondly, we use the model to explore numerically how different OBA schemes manage permit price fluctuations and what are the implications of deducting OBA permits (the majority going to trade-exposed and carbon intensive sectors) from the overall permit allocation so as to keep the total cap on emissions fixed. Our numerical results show that an OBA scheme can significantly reduce carbon price fluctuation as long as its implementation considers a flexible cap on total emissions. Insisting on a fixed cap would only increase price fluctuations and induce severe welfare losses to non-OBA sectors (mainly electricity in the case of the EU-ETS). Furthermore, the introduction of OBA permits together with a flexible global cap generate almost no distortion in these non-OBA sectors.

We think that our results are particularly relevant for the current debate in the EU-ETS. To provide firms with some regulatory certainty regulators need to fix the contractual rules of ETSs, including the cap, long in advance, say in 2005 for the EU-ETS covering the period 2013–2020, or in 2016 for the EU-ETS covering the period 2021–2030. Back in 2005, they were unable to anticipate the uncertainties, such as the severe and durable European recession in market conditions, the new supply fuel sources such as shale gas and their implication on the price of coal, as well the new regulations that were put in place to promote renewable energy production. The unfolding of these uncertainties made the cap committed in 2005 to look little ambitious ex-post, that is, prices clearing at much lower levels than anticipated at the time of setting the cap. Furthermore, EU regulators face numerous legal and political constraints that prevent them from updating their previous commitments.

The inability to provide a long term signal for investment decisions has thrown doubts on the efficiency of the EU-ETS and various proposals to mitigate the problem such as introducing a stability mechanism are currently examined.[5] The EU-ETS is not exceptional in its inability to deliver a reasonable sequence of prices. A similar experience had been observed for the SO_2 market (Schmalensee et al., 1998; Schmalensee and Stavins, 2013). More recently, Borenstein et al. (2015) reviewed the rules in place for the California CO_2 market and showed that it is quite likely that future carbon prices will jump between floor and ceiling of a predetermined price corridor, which had appeared quite large at the time it was set.[6]

Our numerical results show that the introduction of some flexibility in the cap would somehow mitigate the issue of the fluctuation of the carbon price. If optimally designed, an OBA scheme together with a flexible cap ensures that carbon prices fluctuate less and remain closer to the social cost of carbon. All these results indicate that supply and demand shocks make a strong case for the use of OBAs, as long as it is associated with some flexibility in the total cap.

The rest of the paper is organized as follows. The model is presented in Section 2. Policy simulations are in Section 3. We conclude in Section 4. Some mathematical proofs are postponed to the Appendix.

2. Model

Consider an economy with two independent sectors, labeled $i = 1, 2$, each producing an homogenous good. The two sectors are covered by a common permit market, the functioning of which will be described shortly, and is the sole link between the two sectors. The total quantity consumed in sector i is q_i, which is sum of home production q_{ih} and foreign production q_{if}; this latter not subject to any pollution-control policy. Consumer gross surplus in sector $i = 1, 2$ is given by $S_i(q_i, \theta_i)$, where θ_i is a random shock, and the inverse demand function by $P_i(q_i, \theta_i) = \partial S_i(q_i; \theta_i)/\partial q_i$. Shocks θ_1 and θ_2 distribute according to some cumulative distribution function to be defined shortly. Note that these shocks can have both common and sectorial components, so one can write them as $\theta_i = v + \eta_i$, where v could be a shock affecting all sectors in the economy (e.g., recession)

We assume that production, both at home and abroad, is carried out by a group of identical price-taking firms. The cost at home in sector $i = 1, 2$ is given by $C_{ih}(q_i)$ and abroad by $C_{if}(q_{if})$. Output, whether produced domestically or internationally, leads to CO_2 emissions at a rate that is normalized to one, so environmental harm is given by $D(e)$, where $e = q_1 + q_2$ are total emissions.

[3] Note that Roberts and Spence (1976) collapse to a tax if the marginal damage of pollution is constant.

[4] The relative merit of the indexation of the cap to GDP under uncertainty has been studied notably by Quirion (2005) and Newell and Pizer (2008) in the tradition of the comparison of instruments à la Weitzman (1974).

[5] http://ec.europa.eu/clima/policies/ets/index_en.htm.

[6] The benefit of introducing OBA remains even with presence of a price corridor (Meunier et al., forthcoming).