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Compliance and Emissions Trading under the Kyoto Protocol: Rules for Uncertain Inventories

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Abstract A solution is proposed for proving compliance with emission targets and for emissions trading in the event of uncertainties in reported emission inventories. The solution is based on the undershooting concept, from which the mathematical conditions for both proving compliance with a risk α and calculating effective emissions for trading are derived. Based on the reported emission units, the number of permits granted is reduced in proportion to the uncertainty in the inventory. A country whose inventory has higher uncertainty is thereby allotted fewer permits than a country with the same inventory but smaller uncertainty.

Keywords greenhouse gas inventory uncertainty · compliance with Kyoto Protocol · risk of noncompliance · undershooting · emissions trading · effective tradable permits

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1 Introduction

Uncertainty in greenhouse gas (GHG) inventories has been estimated to be in the 5–20% range, depending on the methodology used and its scope (Monni, Syri, Pipatti & Savolainen, 2004a; Rypdal & Winiwarter, 2001). Even if the assumptions of some of the computations need to be unified and possibly recalculated, uncertainty is still believed to be about 10–12% or more for most countries (Winiwarter, 2007) and is therefore typically larger than countries' reduction commitments. Thus, uncertainty seems to be a major problem both in proving compliance and in implementing the flexible mechanisms introduced in the Kyoto Protocol: emissions trading (Article 16[b]); joint implementation (Article 6); and the clean development mechanism (Article 12). In this paper we deal with tradable permits, but the ideas presented can be extended to other mechanisms.

Uncertainty varies among the Parties to the Kyoto Protocol and according to different emissions activities. For example, there are better- or poorer-quality inventories and there are more- or less-credible GHG emission reductions. Thus, under the flexible mechanisms, better- or poorer-quality "goods" are offered for sale or exchange. Should these be treated on an equal basis? In the absence of explicit rules for governing this problem, the market itself is unlikely to resolve it; and

leaving it unresolved may undermine the credibility of the whole emission reduction process.

The problem of uncertainty in inventories is covered somewhat inadequately in the literature. Assessments of uncertainty have been carried out and compared for several countries; see, for example, Charles, Jones, Salway, Eggleston and Milne (1998); Lim et al. (1999); Gawin (2002); Jonas and Nilsson (2001); Monni, Syri and Savolainen (2004b); Nilsson et al. (2000); Rypdal and Winiwarter (2001); Rypdal and Zhang (2000); van Amstel, Oliver and Ruyssenaars (2000); Salway et al. (2002) see also a compendium in Gugele, Huttunen and Ritter (2005). There have been a number of rather vague references to excluding the most uncertain activities from emissions trading (Monni et al., 2004a; Victor, 1991). In Godal (2000) and Godal, Ermolev, Klaassen and Obersteiner (2003) undershooting as the basis for proving compliance is proposed. Similar ideas have been formulated in Gupta, Oltshoorn and Rotenberg (2003) and Gillenwater, Sussman and Cohen (2007). The latter especially presents a solution close to that contained in this paper. A review of other methods, in particular, those related to detectability of changes in emissions, can be found in Jonas et al. (2004a; 2004b).

This paper also argues in favor of the undershooting concept for proving compliance. In contrast to the earlier papers, however, we consider uncertainty in both the base and commitment years that contributes to overall uncertainty when the emission reduction is established. Our proposition starts with setting this shifted-down value on the basis of the risk that the real (as yet unknown) emissions may fail to satisfy the reduction obligation. This may also be interpreted that, apart from the observed greenhouse gas emissions (i.e., the emissions calculated in the inventory), some unobserved emissions, proportional to the amount of uncertainty in the inventory, are also added to the inventory before compliance is checked against obligations. This approach allows us to treat uncertainty of different types (e.g., interval or stochastic uncertainty) in a similar way. To avoid greater changes in the reduction level connected with undershooting, we propose that the undershooting obligation levels for each Party be adjusted appropriately, taking into account the difference between each Party's own uncertainty and an arbitrarily chosen reference level for uncertainty.

The Kyoto Protocol introduces three so-called flexible mechanisms for exchanging emissions between Parties: joint implementation (Article 6); the clean development mechanism (Article 12); and tradable permits (Article 16[b]). In this paper we deal with tradable permits.

The idea of permit trading was established to contribute to the achievement of environmental goals (Montgomery, 1972). It rests on the heterogeneity of emission reduction costs among the market participants, including differences in technology, experience, and availability of natural resources. However, perfect knowledge of the emissions or imissions is assumed. Nordhaus (2005) points to possible trading problems, including those due to different kinds of uncertainties. Our aim is to explicitly include inventory uncertainty in the trading rules, which should, in the long run, stimulate further improvements in the inventory field.

Thus, the compliance-proving rule proposed in this paper is the starting point for a reevaluation of the number of traded emission units that would be achieved by assuming that the uncertainty of the purchased emissions contributes to the buyer's overall uncertainty. A big uncertainty in sold emissions will increase the uncertainty of the buyer's emission balance, making the emissions offered for sale of lower value to the buyer.

This idea is transferred to the definition of an emissions permit under inventory uncertainty. The proposed emissions permit includes uncertainty as follows: a Party with a big inventory uncertainty is allocated fewer emissions permits than a Party with the same emissions and a smaller uncertainty. The permits are subject to normal trading, as in the case of permits where emissions are precisely known.

The idea of changing the trading rules because of the different uncertainties in trading parties' reported emissions also appears in Gillenwater et al. (2007). The starting point, however, is different there, as that approach requires the preservation of some of the common probabilistic