THE IMPACT OF INTRODUCING INTERNATIONAL GREEN CERTIFICATE TRADE UNDER A CARBON EMISSIONS TRADING SYSTEM

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Overview

Growing concerns about climate change have led to a strong promotion of renewable energy. The European Union, for example, is committed to reach a 20% share for renewables in final energy consumption in 2020. To achieve this, the European Council has adopted mandatory differentiated national targets for each of the member states. Since the capacity to realize renewables strongly differs among countries, it can be expected that substantial gains may arise from international cooperation. This already has been assessed in the literature, with cost savings estimates ranging from 10% up to 37%. A potential system that has been proposed to fully exploit the benefits of a cost-effective distribution of renewable energy production is an EU-wide green certificate system. Such a system allows countries to lower their overall costs of meeting the targets by importing foreign certificates instead of realizing their domestic target within their national electricity market. In this paper, we model the impact of international tradable green certificates (TGC) between two countries. Special attention is devoted to the distributional effects. The contribution to the literature is twofold. First, we look at the optimal location of renewable energy resources (referred to hereafter as green production). In the literature, it is often argued that the optimal location involves equating marginal green production costs in all countries. This statement, however, hinges on the assumption that marginal black (non-green) production costs are equal in all countries (e.g., due to unlimited transmission capacity). We show that, when this assumption does not hold, the optimal renewable location may lead to differing marginal green production costs between countries. Second, a partial-equilibrium model is created to assess the production and distributional effects accompanying the introduction of international TGC trade. The literature already contains some work related to this subject. E.g., Amundsen & Nese [1] describe the distributional effects of changing green quota obligations when an international market for green certificates already exists. Other (mostly simulation-based) studies compare the situation before and after the introduction of an international green certificate market. These studies generally conclude that global welfare can be substantially improved, but also that strong distributional effects are likely to arise. To the authors' knowledge, however, no study comprehensively presents the distributional effects of all involved agents accompanying the introduction of TGC trade. This paper aims to address this gap.

Methods

The results are obtained by developing a partial-equilibrium model. The model contains two countries that each have an electricity sector where black and green technologies are used to satisfy the local electricity demand. Moreover, we consider both congested and uncongested electricity trade between both countries. Both countries face a minimum green production constraint expressed as a share of total electricity consumption. Although we only consider two countries, we assume that these act non-strategically and so, we make the implicit assumption that many countries are participating. These assumptions, combined with the necessary convexity assumptions for the black and green cost functions allow to decentralize any welfare optimum via a system of competitive electricity and certificate markets. The model is used to look for a welfare optimum under three regimes for trade in green certificates: no trade, unlimited trade and limited trade.

Results

First, we show that it is generally not optimal to equate marginal green production costs among countries. Instead, the optimal solution involves equalizing the difference between marginal green and black production costs among countries. In the literature, it often is assumed that the cost per additional unit of renewable generation only includes the green production costs. This assumption is only justified if there is unlimited trade in electricity. We show that, when this assumption does not hold, the savings from displaced black production play an important role as well. Countries with high marginal black production costs should thus employ high shares of renewable production when interconnection capacity is limiting, even if those countries are not that well-endowed in green production.

Second, we show the effects of opening an international TGC market on the different agents. We distinguish between the certificate-exporting and certificate-importing country. The certificate-exporting country is obligated to generate sufficient green power to cover its certificate exports on top of its own quota obligation. In turn, the certificate-importing country's quota obligation is relaxed by the amount of certificate imports.

The intra-country redistribution effects are fairly intuitive, but depend on the transmission situation (congested or uncongested). In the certificate-exporting (importing) country, green production will always expend (decrease) relative to the situation without international certificate trade. Furthermore, the effect on consumers and black producers in the certificate-exporting (importing) country may be both negative (positive) as indeterminate, depending on the transmission situation.

The inter-country redistribution effects comprise two effects. First, as argued in the literature, it can indeed be shown that both countries gain in the certificate market. Second, the introduction of certificate trade also impacts the electricity market, which leads to a welfare transfer between both countries if these are engaged in electricity trade. More specifically, the introduction of a common TGC market can affect the average electricity price (both positively and negatively). A decrease of the average electricity price benefits the electricity-importing country at the expense of the electricity-exporting country (and vice versa), representing a welfare transfer in the electricity market. The aggregate of these two welfare components remains indeterminate, implying that one of the countries may become worse off after implementing a common TGC market. Nevertheless, both countries always gain collectively.

Conclusions

The model showed that it generally is not optimal to equate marginal green production costs among collaborating countries. Instead, the difference between marginal green and black production costs among countries should be equal. This result is highly relevant for the design of collaboration schemes. A common green certificate market (or a common feed-in premium), for example, would theoretically accomplish this goal. Collaboration schemes purely based on renewable production costs (e.g., common fixed feed-in tariffs), however, likely cause distortions as they neglect black marginal production costs.

The distributional welfare effects accompanying the introduction of a common TGC market are quite pronounced. First, intra-country redistribution effects may impose political barriers for implementing renewable collaboration systems. Similarly, the inter-country redistribution effects may impose economic barriers. In other words, countries may have incentives to limit certificate trade below the global optimal.

This remains a simple model with two important restrictions: (i) the model is highly aggregated and based on extremely simplifying assumptions, (ii) green production is an objective as such. A more complex model may increase the temporal or technological resolution and endogenize the benefits of green production under the form of cheaper future electricity production (learning by doing) or under the form of other environmental benefits than carbon emission reduction.

References

[1] E. S. Amundsen and G. Nese, "Integration of tradable green certificate markets: What can be expected?," *J. Policy Model.*, vol. 31, no. 6, pp. 903–922, 2009.