Exploring Interaction Effects of Climate Polices: A Model Analysis of the Power Market

By Machiel Mulder and Yuyu Zeng

INTRODUCTION

In order to reduce carbon emissions in the power sector, governments are implementing a set of policy measures. These measures vary from subsidies for renewable-energy techniques to taxes on fossil-fuel electricity production and mechanisms for trading in emission rights. While some measures are taken on the national level, others have an international character. Within the EU, each Member State has to realize the renewable-energy target, but these countries are free to choose their own policies to stimulate deployment of renewable-energy sources. EU countries utilize different measures for this purpose, such as feed-in-tariffs, subsidies and quota systems (Haas et al., 2010). In addition to this, several countries are considering to impose constraints on conventional power plants, in particular coal-fired power plants (EIA, 2014). These measures vary from implementing additional environmental standards (e.g. on fuel efficiency or emissions per unit) which makes it complicated if not impossible for (old) coal-fired power plants to operate or to imposing a carbon tax which, in particular, raises the generation costs of coal-fired power plants.

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Besides this set of different national policy measures to reduce carbon emissions by the power sector, an emissions-trading system has been implemented on the EU level. This EU Emission Trading System (ETS) is the largest cap and trade mechanism in the world in CO_2 emissions. It sets a cap on the total amount of CO_2 emitted by installations of firms subject to this scheme. This cap is reduced annually in order to realize an overall reduction in carbon emissions. The initial allocation of the cap to participants was initially allocated by grandfathering, but more and more auctioning is used as allocation method (EC, 2012). In the secondary market, participants can trade in permits which result in a carbon price.

Together with these climate policies, the European Commission is promoting the integration of national electricity markets to facilitate border-free trading across Europe, see Keay (2013). As a result, national power markets have become more closely integrated with each other, which may increase the international spillovers of national climate policies.

It is well established in economic literature that the coexistence of different types of climate policies may have counteracting effects (Bohringer et al., 2016). This holds in particular when a cap-and-trade emissions scheme is implemented. In that case, theoretically, the level of emissions is only determined by the cap in the emissions trading scheme. If the cap remains the same, other instruments only affect the costs of reaching that target, but not the amount of emissions. If an emissions trading scheme is combined with subsidies for solar panels, for instance, it can be expected that the emissions within the power sector are reduced which lowers the overall demand for and, hence, the price of emissions permits, which in turn can stimulate other firms participating within the emissions trading scheme to raise their emissions since emitting has become cheaper. This effect is called the waterbed effect of climate policy. In this paper, we explore the conditions for the interaction effects to occur.

METHOD

We analyze the interaction of three types of policy measures to realize a transition of the electricity industry based on fossil fuels towards an industry with a lower level of carbon emissions. These policy measures are subsidies for renewable electricity, a fuel tax for fossil-fuel power plants and an international emissions trading scheme. In order to analyze the interaction of different policy measures, we build a concise interconnected two region model with a large and small country in size.

In this model, some producers are perceived as strategic players; hence they can exercise market power and influence the wholesale prices. In our model, international trade is based on price-arbitrage opportunities. The energy trade is realized through the cross-border transmission lines. The size of the cross-border transmission capacity determines the magnitude of international trade and, hence, the potential cross-border spillover effects. Moreover, a carbon market is added to the electricity market, and consequently, the carbon price is part of the variable generation costs of fossil-fuel producers. In addition, we also take the stochastic nature of both supply and demand into account. Firms base their decisions regarding investments and the dispatch of plants on expected values for weather conditions, load levels and scarcity levels. Including probability distributions for wind and demand allows us to control for the volatility of market conditions in the power market.

RESULTS

Using a numerical application of our partial two-country equilibrium model of the power market which also includes a cap-and-trade carbon system, we find spillover effects due to the integration of the two markets. Imposing a fossil-fuel tax in one country leads to a higher cost for fossil-fuel producers. Hence, this country imports more from the neighboring country. As a result of this, we observe a higher utilization of fossil-fuel capacity in the neighboring country. The lower the cap in the emissions-trading system, the stronger this effect appears to be. This result indeed shows that national policies to reduce carbon emissions may be offset by international spillover effects. Coordination of such policies may improve the effectiveness of such policies.

In our Baseline scenario, where subsidies for renewable energy are implemented besides an emissions-trading scheme, the CO_2 price gradually increases over time while the CO_2 emissions reduce in line with the implemented cap on emissions. If on top of these measures a producer tax on carbon is implemented, the carbon price reduces, but we also see a decline in the overall level of emissions (see Figure 1). This result comes from the fact that the carbon price in the trading scheme has a floor, i.e. it can never be lower than zero. If subsidies for renewable energy result in a large amount of renewable-energy capacity this may in some periods, when there are many sunny and windy days, result in an overall demand for carbon permits being below the supply of permits which brings the carbon price to zero. In such circumstances, imposing a tax on the use of fossil fuel reduces the emissions by fossil-fuel plants without being neutralized by a waterbed effect. This effect is stronger the higher the cap.

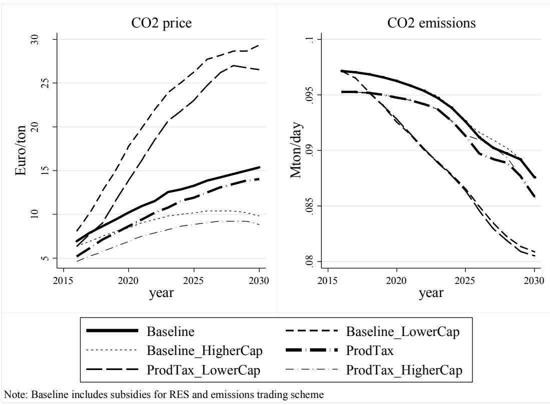

Figure 1: Model results: CO_2 price and CO_2 emissions in 6 policy variants

CONCLUSION

Our findings show that implementing national policies on top of an international emissions trading scheme can still be effective in reducing carbon emissions in spite of the waterbed effect. It appears that the waterbed effect only holds if the cap-and-trade system is constantly binding, which means that there is always a positive price for the carbon permits. The probability of an always binding emissions-trading system reduces if countries keep increasing the size of installed RES capacity, as is currently the case in several European countries.

The policy consequence of this finding is that national climate policies such as subsidy schemes for renewables may have a positive effect on the reduction of carbon emissions, although the general economic literature says that such cannot be the case when an emissions-trading scheme exists. Although adding a carbon tax on top of an emissions trading scheme may result in more emissions reductions as the waterbed effect does not always work, this does of course not mean that such a policy is efficient.

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