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# MARKET POWER RENTS AND CLIMATE CHANGE: A RATIONALE FOR EXPORT TAXES ON COAL?

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## Overview

Coal is both, the fossil fuel with the highest carbon intensity per unit of energy, and an energy carrier that is globally abundant. If climate change is to be kept to tolerable amounts, most of the proven global coal reserves need to be kept in the ground. Restrictions on coal use by importing countries are diffcult to implement and if successful will put fossil fuel exporters at a disadvantage. By contrast, supply side constraints could potentially leave energy exporters better off, through improved terms-of-trade and fiscal revenue from a coal export tax. Eisenack et al.( 2012) follow the same line of arguments, finding that resource owners may benefit from a global carbon cap, while Kalkuhl and Brecha (2013) speak of the distribution of 'climate rents'.

In this paper we investigate the options of resource-rich countries by modeling a hypothetical export tax on steam coal by Australia, the world's second largest steam coal exporter (IEA, 2013), or alternatively by a group of major exporters. This can be motivated by two reasons: rent extraction and climate change mitigation. First, tax revenues are generated against the background of improved terms-of-trade. Although, the international steam coal market can be characterized as being competitive, exporting countries with a high share in international trade may exert an influence on prices (a terms-of-trade effect), and on coal consumption. Second, the implementation of an export tax represents an alternative climate policy instrument focusing on the supply side of carbon. Ultimately, the trade-off between lower extraction levels and higher prices determines the optimal tax level.

In consequence, benefits arise in form of tax revenues and a potential worldwide reduction of carbon dioxide from lower coal consumption. However, the reaction of competing exporters needs to be taken into account. Our model results show that in particular the USA will compensate for reduced Australian exports and sell more steam coal to Asian markets. To this end, US export capacity needs to be expanded. We show that a large rebound, or leakage effect, degrades a unilateral Australian policy and favors the formation of a supply restricting coalition if rent extraction and reduced emissions are to me achived at the same time.

## Methods

We set up the problem as a two level game which is composed of an optimization problem at the upper, and an equilibrium problem at the lower level–a so called Mathematical Equilibrium Problem (MPEC). We set up a partial equilibrium model of the (competitive) international steam coal market at the lower level and apply it numerically. It is based on the COALMOD-World model (cf. Haftendorn et al., 2012), which is calibrated to meet the New Policy Scenario of the World Energy Outlook 2012 (IEA, 2012). It represents global patterns of coal supply, demand and international trade in great detail. Different types of agents, such as producers, and exporters, are defined by specic maximization problems under operational and physical constraints. The model features endogenous investment in production and transportation capacities in a multi-period framework. Prices are determined by market clearing conditions; production and transport costs are exogenously given as are quality conversion factors that differ between production regions.

At the upper level, one country, Australia, or a group of major exporters, maximizes the NPV of its tax revenue by endogenously setting a tax on exports proportional to a carbon tax. This is done by taking into account the impact on prices and quantities in equilibrium, while all market participants take this tax rate parametrically in their decision process. The described two-level problem can be solved with the software GAMS by using different solution methods. In particular, we formulate the problem to solve it with the commercial NLPEC solver, and test for global optimality by means of disjunctive constraints. Here, we follow Gabriel and Leuthold (2010) and discretize the tax rate to avoid any non-linearity.

## Results

Our numerical results suggest a positive and significant Australian export tax rate that maximizes the NPV of tax revenues. We decompose the impact on consumption and production patterns into four partial effects (see Figure 1 that summarizes the results). First, due to the additional costs, Australian exports are smaller than in the base case. Second, since selling on the domestic market is now relatively more attractive, Australian consumption increases, but only to a small extent. Third, production in all other countries increase, and hence lead to a rebound effect. In the first periods, the production of importing countries increases relative to the base case. In particular China reacts to more expensive import opportunities by reducing its trade intensity and by increasing its domestic steam coal production. In later periods, competing exporters increase their production more strongly. The USA increases exports the most, in particular to Asia. US export capacity is expanded to be able to compensate for fewer Australian exports. Fourth, and finally, consumption patterns are altered; global consumption, and hence $CO_2$ emissions, are reduced. The emissions effect is small and the leakage rate is at about 75%.

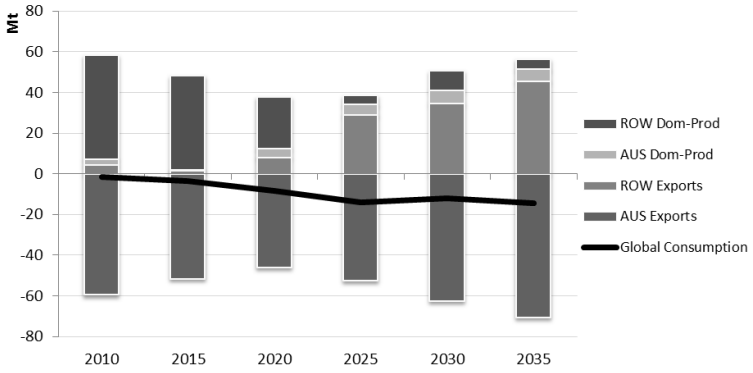


**Figure 1: Change in exports and production for domestic consumption relative to the base case, in Mt.**

This high rebound effect and lower profits of Australian steam coal producers, highlights the disadvantages of a unilateral introduced export tax. Our results suggest that a coaltion of the four largest exporters, Australia, Indonesia, Colombia and South Africa, by contrast can effectively improve their terms-of-trade and benefit from a cooperatively set export tax. Due to a smaller carbon leakage rate, emissions are reduced to a larger extent.

## Conclusions

The numerical analysis in this paper investigates the hypothesis that large coal exporting countries have the option to help achieve global climate change mitigation, and at the same time improve their economic welfare. By restricting coal supply to international markets, they reduce global consumption of coal and can benefit from a terms-of-trade effect and tax revenues. While Australia may unilaterally generate tax revenues, a coalition of the largest exporters is necessary to significantly lower global $CO_2$ emissions and achieve welfare improvements.

We do not investigate the game theoretical properties of cartel formation and stability, and an investigation of why such coal export taxes are not widespread in practice is also left for further work. Moreover, against the introduction of such export taxes and the formation of a cartel are legal obligations under international trade agreements and the possibility of retaliatory trade action by importing countries. Nevertheless, supply constraints by fossil fuel exporters may hold promise as a climate change mitigation strategy, as they can leave the owners of fossil fuel reserves better off, in contrast to the conventional policy approach of policy action on the demand side.

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