The double-dividend of market power rents and climate change mitigation: A rationale for the Australian coal policy?

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(1) Overview

In this paper we investigate a hypothetical implementation of an export tax on steam coal by the Australian government.[1] Such a policy could be motivated by two reasons. First, tax revenues are generated against the background of improved terms-of-trade. Although, the international steam coal market can be characterized as a competitive market, Australia is one of the few major exporting countries. With a share of more than 17% of global steam coal exports (135.4Mt) in 2010 (IEA 2012),[2] Australia can well be characterized as a large market player whose policies have an effect on prices and the patterns of international trade. The second motive may lie in the implementation of an alternative climate policy instrument focusing on the supply side of carbon. Coal is both the fossil fuel with the highest carbon intensity per unit of generated energy and abundant in amounts which must not be combusted to maintain a bearable increase in the global temperature (see e.g. IPCC, 2011, p.172). Australia might play a leading role among resource abundant countries finding a way to balance the interests of climate change mitigation and economic prosperity based on fossil fuel extraction. By reducing overall supplied coal, an export tax may serve as a climate policy.

We construct a two-level problem to explore the consequences of a unilateral policy implementation.[3] At the lower level, a partial equilibrium model of the (competitive) international steam coal market is set up and numerically applied. At the upper level, one country (Australia) maximizes its tax revenue by endogenously setting the tax rate on exports. It can act as a Stackelberg leader taking into account the consequences of the tax change on prices and quantities. The implementation and subsequent increase of an export tax leads to two partial effects. First, domestic production becomes relatively more expensive, both comparative advantages and the domestic extraction are reduced. Hence, the patterns of trade are changed. Second, due to its importance in the international market, a lower Australian supply leads to an increase in the world market price—a terms-of-trade improvement. This effect is equivalent to an exertion of market power of Australian firms and leads to an increase in the sum of profit and tax revenues, until a maximum is reached. 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 levels.

(2) Methods

The described two-level problem is a Mathematical Equilibrium Program (MPEC). The lower level is set up as a mixed complementarity problem replicating the international steam coal market. It is based on the COALMOD-Trade model by Haftendorn and Holz (2010), using updated data for 2010 and being reformulated depending on the chosen solution method. Exporters are the main players maximizing profits by varying their supplied quantities. They are constrained in the amount which can be extracted and exported per period. Prices are determined by market clearing conditions. Production and transport costs are exogenously given as are different quality conversion factors by producer to set up the model in units of energy content (27.20 GJ/tonne for Australia). At the upper level, Australia as the Stackelberg leader introduces a tax based on energy content (which is proportional to a carbon tax) taking the market reaction into account. While all exporters observe that tax rate they take it as parameter in their decision process.

The MPEC is solved in GAMS by using different solution methods. The commercial NLPEC solver is compared to the solution method of a Disjunctive Constraints formulation and a SOS1 Mixed Integer Problem formulation following Siddiqui and Gabriel (2012). While the optimal solution is shown to be equal between all three methods, computation time differs. This will gain importance when employing a large scale model.

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[1] This paper is motivated by the work of Kolstad and Wolak (1985) who analyze the role of strategically set severance tax rates by western US States via numerical simulations.

[2] Most of the Australian production of steam coal is exported—with Japan, Korea, China and China Taipei being the main importers of Australian coal. The average Australian FOB price was 85.82USD/tonne in 2010.

[3] In the single period model, we ignore long-term adjustments of other countries and extracting firms. Short-term capacity constraints consequently lead to an overrated role of the export tax and the numerically estimated value should be seen as an upper limit.

(3) Results

The numerical solution gives an optimal Australian export tax rate on the energy content of coal of 1.509$/GJ. This is about 41 US Dollar per tonne of steam coal—a significant value of roughly 50% of the current FOB export price. Figure 1 depicts tax revenues and tax revenues plus exporter's profits as function of the export tax. Taking the exporter's profits into account the optimal tax rate would be lower, i.e., pure monopoly rents peak at a lower level.

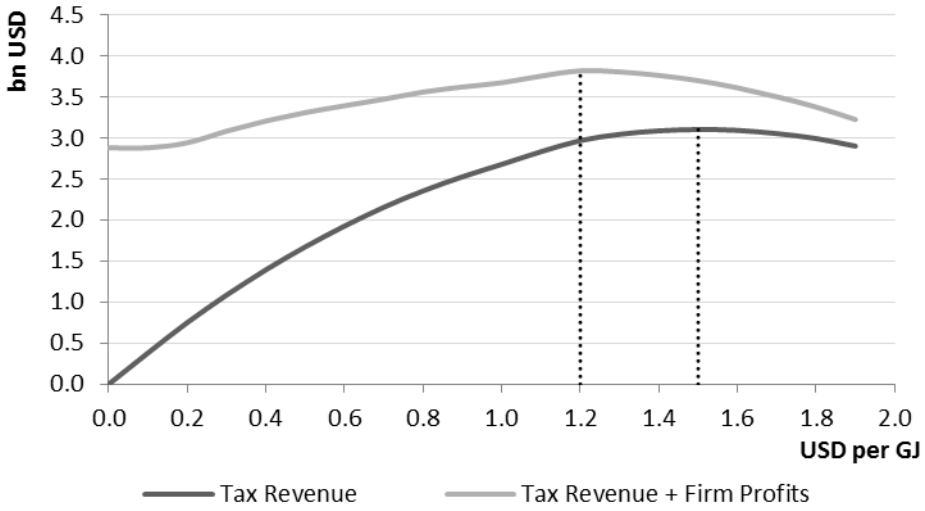

Figure 1: Australian tax revenues with and without profits of Australian firms depending on the chosen tax rate in USD per GJ

The quantity-weighted average world market price significantly increases together with a reduction in world coal consumption. Due to short-term capacity restrictions concerning both the production and the ability to export, other suppliers can only react on a small scale. Hence, the increasing price does not lead to a significant increase in the rest-of-the-world production levels. In accordance to the reduced global coal consumption, carbon dioxide emissions fall—with only a marginal rate of carbon leakage.

(4) Conclusions

By means of a numerical simulation of the international steam coal market we show that an Australian export tax of significant size might be justified serving two motives: rent extraction and climate change mitigation. As a major exporter Australia has an influence on the world market price and may improve its terms-of-trade. While we rely on comparative statics, short term constraints of production and export capacities drive the results and explain the rigidity of other exporters.

Hence, the next modeling step is to focus on a multi-period perspective. This allows integrating endogenous expansions, both of production and infrastructure capacities. An additional countervailing effect of increasing the tax rate might appear: if the export tax is set too high, production may significantly shift towards other countries to the detriment of Australian tax revenues. A second improvement of the model would be the consideration of a multiple objectives function to explicitly model the motive of climate change mitigation. Ultimately, it would be interesting to take into account the reaction of other major exporting countries or the formation of a cartel.

(Selected) References

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