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## **RESOURCE COMPETITION AND CLIMATE CHANGE**

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### **OVERVIEW**

The extraction rate of fossil resources is the most crucial determinant for the speed of the process of global warming. Oil and gas firms compete for future extraction rights of resource stocks which are internationally auctioned as the auction promises higher profits to their owners than own development. Supplementing the literature on supply considerations of resource owners this paper argues that this long-run competition for resource extraction rights is another important driver towards inefficiently high extraction quantities in the short-run. We assume in line with recent examples that the auctioned oil field is awarded to the bidder charging the lowest fee, i.e. having the lowest extraction costs. Within our model, firms are able to gain a competitive cost advantage regarding the exploration of foreign resources via learning-by-doing. The development of domestic oil fields is an investment towards international competitiveness since experience is accumulated which can be applied to any other oil field.

More experienced firms can extract from oil fields at lower costs than their competitors and thus are able to acquire more projects. Therefore firms have an incentive to increase domestic extraction. However, the resulting steeper domestic extraction path implies short-run over-extraction from a global welfare perspective. The inefficiently high extraction follows from the decision process of a single oil firm which chooses to increase the current extraction rate in order to attract more future extraction rights but neglects the negative externality on the other participants by reducing their extraction shares.

### **METHODS**

In our model of resource competition we combine two already very well developed strings of literature that were treated completely separate so far: The theory of optimal inter-temporal resource extraction and the modelling framework of the theory of tax competition á la [2]. We modify the tax competition model to explain how oil firms are competing for oil fields, e.g. deep-water resources or the recently auctioned Iraqi oil fields, on the international auction market. In equilibrium, the auctioned resource stock is extracted at the lowest cost via an equalization of marginal extraction costs between the extracting oil firms. The resulting arbitrage condition can be used to solve the dynamic optimisation problem of the oil firm with regard to its extraction of previously acquired resources and its aggressiveness towards international competitiveness.

According to [1], optimal inter-temporal extraction implies that the change over time of marginal profit of the resource in-situ equals the return on above-ground (financial) capital. Therefore the marginal profit of extraction has to rise with the interest rate over time, if the latter in fact is the return on invested capital. We transfer this argument into a two-period model in which oil firms (in a broader context to be interpreted as countries) individually and non-cooperatively maximise their profit from their total oil extraction. In addition to their domestic, i.e. previously acquired, resource stock each firm can participate in the competition for foreign resources which are allocated according to our arbitrage condition on an international auction market before period two. We explain in-depth how oil firms are able to

follow a learning curve by pursuing domestic extraction, so that in consequence a higher domestic extraction volume leads to an increase in competence with regard to foreign oil fields. In turn more domestic extraction in period one decreases the extraction costs of the oil firm for a given kind of oil field in period two; thus our model incorporates a learning-by-doing effect on which oil firms are able to capitalise in the international competition.

## **RESULTS**

The existence of a large pool of international resource stocks in period two incentivises oil firms to expand extraction of already acquired oil resources in period one. In doing so, they acquire specific competence via a learning-by-doing argument which plays a key role in winning contracts on the international auction market for oil fields. Given a non-cooperative setting each oil firm achieves its highest possible discounted cash-flow. However, the resulting extraction quantities imply two problems: Firstly, the Hotelling consideration that already includes the benefits from cost savings due to a movement along the learning curve is distorted as the possibility of enlarging an individual firm's extractable resource stock puts pressure on all firms to compete for the international resources. A deviation from a social welfare function follows since lower (i.e. welfare-optimal) domestic extraction of a firm implies a lower international competitiveness compared to firms which have enlarged their extraction volumes. It pays off for a firm to bear an inefficiency regarding the optimal domestic extraction rule as long as its share in the international resource market compensates for that. Secondly, the inefficient push along the learning curve leads under certain conditions to a transfer of rents from the oil firms to the owners of the auctioned oil fields.

## **CONCLUSIONS**

From a welfare point of view, extraction would be optimal without insecurity regarding the future distribution of internationally available resources. The first-best equilibrium, i.e. the social planner solution, exhibits in addition to the optimal inter-temporal extraction path for each firm also cost efficiency with regard to international oil extraction by choosing an optimal distribution of the available resources. Allocating property shares to firms today would freeze the competition for resources. Firms which are sure about their overall extraction volumes will follow the optimal inter-temporal extraction path as no competitor threatens their future extraction possibilities and a higher extraction would not pay off in larger future market shares. Obviously, the drawback of distributing shares of international resource stocks to extracting firms today does not necessarily imply cost efficiency which is otherwise guaranteed by the auction market.

Within the auction market setting an appropriate tax on the remuneration fee, which reduces the profitability of internationally auctioned oil fields, seems to be a promising policy instrument to reduce the firms' incentive for short-run over-extraction. For the actual design of the tax many aspects have to be taken into account and international coordination would be necessary to avoid the emergence of another layer of harmful competition.

## **REFERENCES**

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