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THE EVOLUTION OF EUROPEAN COAL SUPPLY SECURITY IN THE FACE OF CHINA´S GROWTH

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OVERVIEW

The steam coal market has been growing very dynamically during the last years. Especially China's demand and production has been outperforming overall market growth. Since the record prices seen in 2008 and the subsequent collapse, China has evolved to be the second largest net importer world wide after Japan. Facing continued massive demand growth, it is possible that China will further increase its imports in the next years and thus become by far the most important actor on the international market. It will be of special importance for the future supply security of other countries mainly depending on steam coal imports like, for example, many European nations how fast China will be able to ramp up new mine capacities. We use a quantitative bottom-up model to answer these questions.

METHODS

We develop an inter-temporal spatial equilibrium model for the global steam coal market up to the year 2030. It minimises production costs, transportation costs and investment costs of all market actors during the model horizon. The model consists of a set of nodes representing export terminals, mine regions and import regions. The nodes are interconnected by a set of arcs representing inland transportation routes and sea routes for bulk carrier vessels. This modelling approach is similar to that found in [1] and [2]. We included mine nodes for all major exporting regions in the model as well as the domestic markets of the US and China. We further included all significant importing regions. We model the marginal mine costs as convex functions which sharply increase if production volumes approach the capacity constraint (see [3]). The model is able to endogenously invest into new mine capacity in selected regions as well as into export terminal throughput capacity. New regions where mining could take place in the future are implemented. The coal volumes are normalised according to average calorific values to account for different coal qualities between countries. Inland transportation is capacity constrained were data is available.
Historical data regarding export mine costs and capacities and transportation are taken from the extensive analysis in [4]. Information about production, demand and transportation for the domestic markets in the US and China stems from a variety of sources (e.g. [5] and [6]). We model the future evolution of marginal mine costs during the model horizon by estimating the relative change of mine production input factors and adjusting our mine cost functions with the weighted input prices. Prices of mine production input factors depend on a number of commodities, especially on oil prices, productivity, labour costs and steel. Demand projections are based on the reference scenario of the EIA [7].
The model is formulated in the MCP format by deriving the first order optimality conditions of the original minimisation problem. The model is implemented in GAMS using the Solver PATH (cf [8]).

RESULTS

In a first step we investigate two scenarios: (1) A scenario were we assume rapid exploration of new cost-competitive coal fields in Manchuria and the western provinces combined with burning the coal at mine-mouth power plants to avoid transport by railway (“coal-by-wire”), (2) A second scenario were we assume that most of the future steam coal production will still have to take place in more expensive mine fields already operating today combined with conventional railway transportation to the demand centres. We perform sensitivity analyses for both scenarios for high and low oil prices.

Preliminary scenario results are shown in table 1. Scenario (1) leads to moderate coal imports for China and therefore a relaxed price evolution for European importing countries until 2030. However, in scenario (2) European import prices rise by more than 25% as Chinese imports soar to over 300 Mt. South African coal supply completely shifts to the pacific basin. Alone in the Pacific export market region an additional 75 Mt of mine capacity is developed compared to scenario (1) to compensate for China’s growth of coal imports.

Table 1. Selected results of the scenario analysis

Model results	**Dimension**	**Scenario (1) -2030 New mine fields & “coal-by-wire”**	**Scenario (2) -2030 Conventional mine fields**
Marginal costs - Europe	USD_{2009}/t	97	123
Marginal costs - China port	USD_{2009}/t	104	148
Imports - China	Mt	130	336

CONCLUSIONS

We find that coal transport infrastructure investments and coal field developments in China are a major determinant for future Chinese steam coal imports and European supply security. European import prices rise significantly if no new mine fields and grid infrastructure is developed. Such price increases will affect European power plant fleets, especially the future cost competitiveness of coal-based CCS generation technologies in Europe from 2020 onwards.

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