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# Optimizing Global Thermal Coal Shipments

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## Abstract

Thermal coal is used to produce energy; with changing emissions standards and advances in renewable technology, the thermal coal market has seen significant transformation over the past decade. We develop a mixed-integer optimization problem that seeks to minimize shipment costs while meeting demand for thermal coal, and which respects quality constraints, supply limits, and port capacity; we use this model to analyze the following scenarios: (i) a counterfactual setting in which we compare historical shipping patterns to model results using a 2012 base year; (ii) the explicit effect of Chinese mandates on coal shipments; (iii) the impact on our shipping patterns of reduced Chinese and Indian demand; (iv) the effects of the Baltic Dry Index and oil prices; and (v) a comparison of shipments prior and subsequent to Panama Canal expansion. Our work can be used to inform policy, study responses to variable price and demand scenarios, and provide insight to both coal producers and consumers about the international coal market. For example, removal of mandates set by the Chinese government to fill its own demand decreases coal flows from Northern to Southern China by 56%, which has a spill-over effect on European and American markets; and, expansion of the Panama Canal leads to only modest shipping increases through the canal (6.7%), with more coal originating from

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