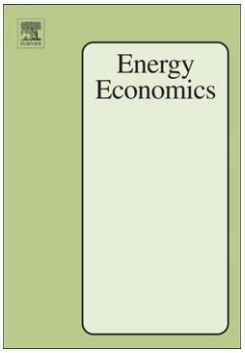

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Robust Portfolio Optimization for Electricity Planning: An Application Based on the Brazilian Electricity Mix

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Abstract

One of the major challenges of today's policy makers and industry strategists is to achieve an electricity mix that presents a high level of energy security within a range of affordable costs and environmental constraints. Bearing in mind the planning of a more reliable electricity mix, the main contribution of this paper is to consider parameter uncertainties on the electricity portfolio optimization problem. We assume that the expected and the covariance matrix of the costs for the different energy technologies, such as gas, coal, nuclear, oil, biomass, wind, large and small hydropower, are not exactly known. We consider that these parameters belong to some uncertainty sets (box, ellipsoidal, lower and upper bounds, and convex polytopic). Three problems are analyzed: (i) finding a energy portfolio of minimum worst case volatility with guaranteed fixed maximum expected energy cost; (ii) finding an energy portfolio of minimum worst case expected cost with guaranteed fixed maximum volatility of the energy cost; (iii) finding a combination of the expected and variance of the cost, weighted by a risk aversion parameter. These problems are written as quadratic, second order cone programming (SOCP), and semidefinite programming (SDP), so that robust optimization tools can be applied. These results are illustrated by analyzing the efficient Brazilian electricity energy mix considered in [1] assuming possible uncertainties in the vector of expected costs and covariance matrix. The results suggests that the robust approach, being by nature more conservative, can be useful in providing a reasonable electricity energy mix conciliating CO_2 emission, risk and costs under uncertainties on the parameters of the model.

Keywords: electricity planning, policy-making, mean-variance, robust optimization, uncertainty, portfolio theory.

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