

# Risk trading in capacity equilibrium models

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**Gauthier de Maere d'Aertrycke, Andreas  
Ehrenmann, Daniel Ralph, and Yves Smeers**

**Abstract** We present a set of power investment models, the class of *risky capacity equilibrium problems*, reflecting different assumptions of perfect and imperfect markets. The models are structured in a unified stochastic Nash game framework. Each model is the concatenation of a model of the short-term market operations (perfect competition or Cournot), with a long-term model of investment behavior (risk neutral and risk averse behavior under different assumptions of risk trading). The models can all be formulated as complementarity problems, some of them having an optimization equivalent. We prove existence of solutions and report numerical results to illustrate the relevance of market imperfections on welfare and investment behavior. The models are constructed and discussed as two stage problems but we show that the extension to multistage is achieved by a change of notation and a standard assumption on multistage risk functions. We also treat a large multistage industrial model to illustrate the computational feasibility of the approach.

**Keywords** Capacity expansion, spot market, perfect or Cournot competition, risk aversion, risk trading, complete or incomplete risk market, coherent risk measure, risky capacity equilibria

**JEL Classification** C62, D25, C72, L94, C73, G32

Contact  
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[d.ralph@jbs.cam.ac.uk](mailto:d.ralph@jbs.cam.ac.uk)  
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