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# Lot sizing with storage losses under demand uncertainty

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**Abstract** We address a variant of the single item lot sizing problem affected by proportional storage (or inventory) losses and uncertainty in the product demand. The problem has applications in, among others, the energy sector, where storage losses (or storage deteriorations) are often unavoidable and, due to the need for planning ahead, the demands can be largely uncertain. We first propose a two-stage robust optimization approach with second-stage storage variables, showing how the arising robust problem can be solved as an instance of the deterministic one. We then consider a two-stage approach where not only the storage but also the production variables are determined in the second stage. After showing that, in the general case, solutions to this problem can suffer from acausality (or anticipativity), we introduce a flexible affine rule approach which, albeit restricting the solution set, allows for causal production plans. A hybrid robust-stochastic approach where the objective function is optimized in expectation, as opposed to in the worst-case, while retaining robust optimization guarantees of feasibility in the worst-case, is also discussed. We conclude with an application to heat production, in the context of which we compare the different approaches via computational experiments on real-world data.

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