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Title: A Parametric Programming Approach to Bilevel Electricity Transmission Investment Problems with Lower-Level Variables in the Upper Level

Abstract: This paper examines linearly constrained bilevel programming problems in which the upper level objective function depends on both the lower-level primal and dual optimal solutions. We parametrize the lower-level solutions and thereby the upper-level objective function by
the upper-level variables and argue that it may be non-convex and even discontinuous. However, when the upper-level objective is affine in the lower-level primal optimal solution, the parametric function is piece-wise linear. We show how this property facilitates the application
of parametric programming and demonstrate how the approach allows for decomposition of a separable lower-level problem. When the upper-level objective is bilinear in the
lower-level primal and dual optimal solutions, we also provide an exact linearization method
that reduces the bilevel problem to a single-level mixed-integer linear programme (MILP). We assess the performance of the parametric programming approach on two case studies of strategic investment in electricity markets and benchmark against state-of-the-art MILP and non-linear solution methods for bilevel optimization problems. Preliminary results indicate
substantial computational advantages over several standard solvers, especially when the lower-level problem separates into a large number of subproblems. Furthermore, we show that the parametric programming approach succeeds in solving problems to global optimality for which standard methods can fail.

Key words: MPEC, power markets, investments, algorithms