A matheuristic for the design and planning of a closed loop supply chain with time stochastic dominance constraints

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The design and operation planning of a multi-period, multi-product closed loop supply chain is addressed, where the original equipment manufacturer operates the forward and reverse supply chain. Recovered products from customers that are end-of life products, are evaluated in disassembly centers and accordingly are sent back to facilities for remanufacturing, or leave the network either by being sold to third parties or by being sent to disposal. Due to the large uncertainty present, several problem parameters such as transportation costs, product demands, returned product volumes and returned product evaluations are considered to be stochastic, see [1]. Further, different topology decisions are to be defined at different stages of the time horizon so that topological decisions are dynamic. In order to address this problem a two-stage stochastic programming model is developed where the classical risk neutral and an extension to a risk averse attitude are presented. A profit risk reduction is performed by using a risk averse measure, so-called stochastic dominance one, included by a set of profiles to be satisfied as a profit target for the groups of scenarios as a whole with a one-to-one correspondence with the nodes in a modeler-driven subset of periods in the scenario tree. Each profile is included by a 3-tuple given by a threshold, a chance-constrained of its infeasibility (also so-named a bound on the first order SD, see [3]) and a bound on the corresponding infeasible value (also so-named a bound on the expected second-order SD value, see [2]. An example based on a real case shows the model's applicability by comparing the risk neutral and risk averse models as well as the add-value of several variants of the risk averse strategy in a context of very risky scenarios.

References

[1] Baptista, S., Escudero, L.F., Gomes, M.I., Pizarro, C. On risk management of a two-stage stochastic mixed 0-1 model for the closed-loop supply chain design problem Submitted, 2017.

[2] Gollmer, R., Gotzes, U., Schultz, R. A note on second-order stochastic dominance constraints induced by mixed-integer linear recourse. Mathematical Programming, Ser. A, 126:179-190, 2011.

[3] Gollmer, R., Neise, F., Schultz, R. Stochastic programs with first-order stochastic dominance constraints induced by mixed-integer linear recourse. SIAM Journal on Optimization, 19:552-571, 2008.