

**AUTHOR:** Vadim Omelcenko

**TITLE:** Problems of Stochastic Optimization under Uncertainty, Quantitative Methods, Simulations, Applications in Gas Storage Valuation

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**REVIEWER:** Associate Professor Sergio Ortobelli Lozza

The doctoral dissertation thesis of Mr. Omelcenko firstly recalls the status quo of the topic and the aim of the dissertation. Then the author examines some statistical methods for heavy tail distributions and their possible applications to the Gas storage valuation problem.

After the introduction, the main part of the dissertation thesis consists of three chapters (1, 2, and 3). Chapter 1 introduces stable distributions and their properties, then it examines a sub-family of generalized stable distributions and it discusses an alternative estimation method and its application to electricity and gas. The estimation method seems to be promising for practitioners. In the Chapter 2 the author examines some stochastic dominance rules for Pareto distributions and the Stable Paretian distributions. While the rules proved for Pareto distributions appear interesting (even for their application to the sum of iid Pareto), the other rules were essentially proved in the recent literature. Chapter 3 discusses the problem of a gas storage unit valuation and provides a methodology based on stochastic dominance constraints to solve the problem. This last chapter probably represents the most innovative part of the thesis.

Since the thesis introduces some innovative and original ideas and methods, I believe that the dissertation thesis fulfils the requirements for a doctoral dissertation thesis. **Therefore, I recommend the thesis of Mr. Omelcenko for the final defense.**

#### **Comments:**

1. The definition of stochastic dominance relations is given at beginning of chapter 2. I suggest to clarify in the definitions whether weak or strong dominance are considered.
2. (Some problems with formal statements). Sometimes in the thesis the author forgets some hypothesis (or there are some misprints). Please adjust them.
  - a) See for example Theorem 5 and Corollary chapter 1 page 10 he forgets the assumption of "independent random variables". The same happen for theorem 27 chapter 2 page 56.
  - b) In the Corollary of chapter 1 page 10 a "beta" is missing
  - c) I believe the author should control and discuss the case of  $\alpha=2$  (corresponding to the domain of attraction of a Gaussian law) in Theorem 22 (written in that form cannot be correct since the scale parameter of the symmetric Pareto is equal to 0 for  $\alpha=2$ ). Moreover, the domain of attraction is fundamental also for the type of analysis proposed by the author.
3. I believe that the results related to bivariate stable families can be improved considering :
  - a) The connection between this extension and the multi-tail elliptical distribution proposed by Kring et al. 2009.
  - b) Try to evaluate and compare his results with the bivariate tail elliptical distribution.
4. Unfortunately, some results of Chapter 2 are known. Clearly, a deeper discussion of the state of the art should be done. Let me give some advices on this chapter:

- a) The crossing results of theorem 15, 16 page 41 are old results from Hanoch and Levy (1969) that has been extended even for other orderings (see among others Ortobelli et al. 2016a)
  - b) The stochastic dominance relationships among the scalar and location parameters of any translation and scalar invariant family of distributions (such as the stable Paretian family) are well known in literature (see among others, Ortobelli and Rachev 2001). Thus, Theorem 25 and part of Theorem 27 pages 50, 56 do not present strong news. Similarly, Lemmas 5 and 6 can be found in classic books of stochastic orderings (see, for example, Theorem 3.A.5 (d) Shaked and Shanthikumar (1993))). However, I recognize that the idea of using the asymptotic behavior of some Symmetric Pareto families of distributions to prove their ordering is a good idea that hasn't been used in ordering literature.
  - c) The author must consider the work about orderings of univariate stable distributions (see Ortobelli et al. 2016a) to examine some possible extensions of his thesis.
  - d) In the multivariate setting the author could examine if the ordering among sub-Gaussian laws (introduced in Ortobelli et al 2016b) can be extended to the bivariate stable distributions introduced in chapter 1.
5. Chapter 3 proposes some interesting applications of heavy tail literature to the gas storage problem. In this context, he also considers some stochastic dominance constraints. One idea could be to consider the effects of using more detailed asymptotic orders (as suggested in Ortobelli et al. 2016a) in the optimization problem (when it is possible). Observe that using the McCulloch's algorithm (1986) to evaluate stable parameters the parameters are determined using recursively a linear program. Thus, the complexity of your problem should not increase too much.

#### References:

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- 2) Ortobelli S., Lando T., Petronio F., Tichy T. (2016a) Asymptotic stochastic dominance rules for sums of iid random variables, *Journal of Computational and Applied Mathematics* 432-448
- 3) Ortobelli S., Lando T., Petronio F., Tichy T. (2016b) "Asymptotic Multivariate Dominance: A Financial Application" *Methodology and Computing in Applied Probability*. doi:10.1007/s11009-016-9502-y
- 4) Shaked, M., Shanthikumar, G. (1993): *Stochastic orders and their applications*. New York: Academic Press Inc. Harcourt Brace & Company.
- 5) G. Hanoch, H. Levy, The efficiency analysis of choices involving risk, *Rev. Econom. Stud.* 36 (3) (1969) 335-346.
- 6) Ortobelli S. Rachev, S.T.(2001): "Safety first analysis and stable Paretian approach" Elsevier Science Ltd. *Mathematical and Computer Modelling*, 34, 1037- 1072.

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