

## Quasi-Copulas with Quadratic Sections in One Variable

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*Abstract:* We introduce and characterize the class of multivariate quasi-copulas with quadratic sections in one variable. We also present and analyze examples to illustrate our results.

*Keywords:* 1-Lipschitz condition; copula; quasi-copula; quadratic sections;

*AMS Subject Classification:* 60E05; 26B99;

### References

- [1] C. Alsina, R. B. Nelsen, and B. Schweizer: On the characterization of a class of binary operations on distribution functions. *Statist. Probab. Lett.* 17 (1993), 85–89.
- [2] I. Cuculescu and R. Theodorescu: Copulas: diagonals and tracks. *Rev. Roumaine Math. Pures Appl.* 46 (2001), 731–742.
- [3] B. De Baets, H. De Meyer, and M. Úbeda-Flores: Extremes of the mass distribution associated with a trivariate quasi-copula. *C. R. Acad. Sci. Paris, Ser. I* 344 (2007), 587–590.
- [4] B. De Baets, H. De Meyer, B. De Schuymer, and S. Jenei: Cyclic evaluation of transitivity of reciprocal relations. *Soc. Choice Welf.* 26 (2006), 217–238.
- [5] F. Durante, J. J. Quesada-Molina, and M. Úbeda-Flores: On a family of multivariate copulas for aggregation processes. *Inform. Sci.* 177 (2007), 5715–5724.
- [6] C. Genest, J. J. Quesada-Molina, J. A. Rodríguez-Lallena, and C. Sempi: A characterization of quasi-copulas. *J. Multivariate Anal.* 69 (1999), 193–205.
- [7] S. Janssens, B. De Baets, and H. De Meyer: Bell-type inequalities for quasi-copulas. *Fuzzy Sets Syst.* 148 (2004), 263–278.
- [8] E. P. Klement and A. Kolesárová: 1-Lipschitz aggregation operators, quasi-copulas and copulas with given diagonals. In: *Soft Methodology and Random Information Systems* (M. López-Díaz, M. A. Gil, P. Grzegorzewski, O. Hryniewicz, and J. Lawry, eds.), *Advances in Soft Computing*, Berlin 2004, pp. 205–211.

- [9] E. P. Klement and A. Kolesárová: Extension to copulas and quasi-copulas as special 1-Lipschitz aggregation operators. *Kybernetika* 41 (2005), 329–348.
- [10] E. P. Klement and A. Kolesárová: Intervals of 1-Lipschitz aggregation operators, quasi-copulas, and copulas with given affine section. *Monatsh. Math.* 152 (2007), 151–167.
- [11] A. Kolesárová: 1-Lipschitz aggregation operators and quasi-copulas. *Kybernetika* 39 (2003), 615–629.
- [12] R. B. Nelsen: *An Introduction to Copulas*. Second edition. Springer, New York 2006.
- [13] R. B. Nelsen and M. Úbeda-Flores: The lattice-theoretic structure of sets of bivariate copulas and quasi-copulas. *C. R. Acad. Sci. Paris, Ser. I* 341 (2005), 583–586.
- [14] R. B. Nelsen, J. J. Quesada-Molina, J. A. Rodríguez-Lallena, and M. Úbeda-Flores: Multivariate Archimedean quasi-copulas. In: *Distributions with Given Marginals and Statistical Modelling* (C. Cuadras, J. Fortiana, and J. A. Rodríguez, eds.), Kluwer, Dordrecht 2002, pp. 179–185.
- [15] R. B. Nelsen, J. J. Quesada-Molina, J. A. Rodríguez-Lallena, and M. Úbeda-Flores: Best-possible bounds on sets of bivariate distribution functions. *J. Multivariate Anal.* 90 (2004), 348–358.
- [16] R. B. Nelsen, J. J. Quesada-Molina, J. A. Rodríguez-Lallena, and M. Úbeda-Flores: On the construction of copulas and quasi-copulas with given diagonal sections. *Insurance: Math. Econom.* 42 (2008), 473–483.
- [17] R. B. Nelsen, J. J. Quesada-Molina, B. Schweizer, and C. Sempi: Derivability of some operations on distribution functions. In: *Distributions with Fixed Marginals and Related Topics* (L. Rüschendorf, B. Schweizer, and M. D. Taylor, eds.), CA: IMS Lecture Notes – Monograph Series Number 28), Hayward 1996, pp. 233–243.
- [18] J. J. Quesada-Molina and J. A. Rodríguez-Lallena: Bivariate copulas with quadratic sections. *J. Nonparametr. Statist.* 5 (1995), 323–337.
- [19] J. J. Quesada-Molina, S. Saminger-Platz, and C. Sempi: Quasi-copulas with a given sub-diagonal section. *Nonlinear Anal.* 69 (2008), 4654–4673.
- [20] J. A. Rodríguez-Lallena and M. Úbeda-Flores: Best-possible bounds on sets of multivariate distribution functions. *Comm. Statist. Theory Methods* 33 (2004), 805–820.
- [21] J. A. Rodríguez-Lallena and M. Úbeda-Flores: Compatibility of three bivariate quasi-copulas: Applications to copulas. In: *Soft Methodology and Random Information Systems* (M. López-Díaz, M. A. Gil, P. Grzegorzewski, O. Hryniewicz, and J. Lawry, eds.), *Advances in Soft Computing*, Springer, Berlin 2004, pp. 173–180.
- [22] J. A. Rodríguez-Lallena and M. Úbeda-Flores: Multivariate copulas with quadratic sections in one variable. To appear.

- [23] J. A. Rodríguez-Lallena and M. Úbeda-Flores: Some new characterizations and properties of quasi-copulas. To appear in *Fuzzy Sets and Systems*. doi: 10.1016/j.fss.2008.02.007.
- [24] S. Saminger, B. De Baets, and H. De Meyer: On the dominance relation between ordinal sums of conjunctors. *Kybernetika* 42 (2006), 337–350.
- [25] A. Sklar: Fonctions de répartition à  $n$  dimensions et leurs marges. *Publ. Inst. Statist. Univ. Paris 8* (1959), 229–231.
- [26] A. Sklar: Random variables, joint distributions, and copulas. *Kybernetika* 9 (1973), 449–460.
- [27] M. Úbeda-Flores: A new family of trivariate proper quasi-copulas. *Kybernetika* 43 (2007), 75–85.