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A. Khosravi Tanak, G.R. Mohtashami Borzadaran, J. Ahmadi

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Maximum Tsallis entropy with generalized Gini and Gini mean difference indices constraints

A. Khosravi Tanak, G. R. Mohtashami Borzadaran*, J. Ahmadi

Department of Statistics, Ferdowsi University of Mashhad, P.O. Box 1159 Mashhad 91775, Iran

Abstract

Using the maximum entropy principle with Tsallis entropy, some distribution families for modeling income distribution are obtained. By considering income inequality measures, maximum Tsallis entropy distributions under the constraint on generalized Gini and Gini mean difference indices are derived. It is shown that the Tsallis entropy maximizers with the considered constraints belong to generalized Pareto family.

Keywords: Tsallis entropy, Maximum entropy, Generalized Gini index, Gini mean difference, Euler's equation, Generalized Pareto distribution

1. Introduction

The maximum entropy approach for estimating the probability density function (pdf) was originally proposed by Jaynes [12], and since then has been widely used in many research areas, particularly in economics. The maximum entropy principle can be traced back to Jaynes' classical description: "The fact that a probability distribution maximizes entropy subject to certain constraints representing our incomplete information, is the fundamental property which justifies use of that distribution for inference; it agrees with everything that is known, but carefully avoids assuming anything that is not known." Maximization of Shannon entropy [27] with different constraints have been studied by many researchers such as Kapur [14] and Kagan et al. [13].

In economics and the social sciences, estimating income distribution with regard to income inequality in society is of interest. Entropy maximization based on inequality measure constraints has been considered by several authors. Holm [11] obtained a family of pdfs by using maximum Shannon entropy principle under mean and Gini index constraints. Ryu [26] determined the functional form of the share function by maximum Shannon entropy method under the constraint on the Bonferroni index. Eliazar and Sokolov [7] and [8] found the distribution that maximizes Shannon entropy subject to a given mean and Gini index, and mean and Pietra index, respectively. Khosravi et al. [16] obtained the maximum entropy distribution with the constraints on mean and generalized Gini index and they showed that the proposed distribution fits to US income data better than alternatives. Nakhaei et al. [23] used the maximum entropy method to estimate the unknown true income share function based on the known generalized Gini index.

The maximizers of another entropy, the Tsallis entropy [28], have a high interest in many applied fields, namely economy, biology, and physics [24]. The maximum Tsallis distributions have encountered a large success because of their remarkable agreement with experimental data, see for instance [3, 29] and references therein. Recently, some works have been done in the subject of Tsallis entropy maximization with inequality measures constraints. Riabi et al. [32] obtained a family of Lorenz curves by Tsallis entropy maximization under mean and Gini index constraints. Preda et al. [25] found some new classes of distributions by maximizing Tsallis entropy under mean and Gini equality and inequality constraints. In this paper, we apply the maximum entropy principle with Tsallis entropy under the constraints on generalized Gini and Gini mean difference indices to approximate income distribution. We show that

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*Corresponding author

Email addresses: khosravi.a_66@yahoo.com (A. Khosravi Tanak), grmohtashami@um.ac.ir (G. R. Mohtashami Borzadaran), ahmadi-j@um.ac.ir (J. Ahmadi)