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ScienceDirect
Journal of Econometrics 138 (2007) 568–585
JOURNAL OF Econometrics
www.elsevier.com/locate/jeconom

Information measures for generalized gamma family

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Available online 30 June 2006

Abstract

The objective of this paper is to integrate the generalized gamma (*GG*) distribution into the information theoretic literature. We study information properties of the *GG* distribution and provide an assortment of information measures for the *GG* family, which includes the exponential, gamma, Weibull, and generalized normal distributions as its subfamilies. The measures include entropy representations of the log-likelihood ratio, AIC, and BIC, discriminating information between *GG* and its subfamilies, a minimum discriminating information function, power transformation information, and a maximum entropy index of fit to histogram. We provide the full parametric Bayesian inference for the discrimination information measures. We also provide Bayesian inference for the fit of *GG* model to histogram, using a semi-parametric Bayesian procedure, referred to as the maximum entropy Dirichlet (MED). The *GG* information measures are computed for duration of unemployment and duration of CEO tenure.

JEL classification: C11; C14; C15; C16; C41; C52

Keywords: Entropy; Exponential; Gamma; Kullback–Leibler information; Model fitting; Weibull

1. Introduction

The generalized gamma (*GG*) distribution offers a flexible family in the varieties of shapes and hazard functions for modeling duration. It was introduced by Stacy (1962).

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0304-4076/$ - see front matter
doi:10.1016/j.jeconom.2006.05.010

Difficulties with convergence of algorithms for maximum likelihood estimation (Hager and Bain, 1970) inhibited applications of the *GG* model. Prentice (1974) resolved the convergence problem using a nonlinear transformation of *GG* model. However, despite its long history and growing use in various applications, the *GG* family has been remarkably absent in the information theoretic literature. Thus far a maximum entropy (ME) derivation of *GG* is given in Kapur (1989), where it is referred to as generalized Weibull distribution, and only recently the entropy of *GG* has appeared in the context of flexible families of distributions (Nadarajah and Zografos, 2003). The *GG* family has not been included in information studies such as the existing ME distributional fitting of the parametric families (see, e.g., Soofi and Retzer, 2002 and references therein), the discrimination information statistics analysis of the parametric families (Alwan et al., 1998), and the entropy orderings of the parametric families (Ebrahimi et al., 1999). The main objective of this paper is to fill this void and integrate the *GG* family into the information theoretic literature. For this purpose, we develop information criteria for discriminating between the *GG* and its subfamilies and for assessing the fit of *GG* to the data. We also present Bayesian inference about the discrimination and the fit.

Analysis of duration data is increasingly used in various areas of economics and related fields (Keifer, 1988). In labor economics, examples include studies of the duration of unemployment, (Lancaster, 1979; Kiefer, 1984; McDonald and Butler, 1987; Yamaguchi, 1992), turnover in labor market (Kiefer et al., 1985), length of contract (Gronberg, 1994), and duration of strike (Jaggia, 1991). Examples in other areas include studies of firms survival (Audretsch and Mahmoud, 1995), duration that firms spend under Chapter 11 (Orbe et al., 2002), duration that a property is on the market (Genesove and Mayer, 1997), duration of schooling at higher education (Diaz, 1999), duration of stages of oilfield exploration (Favero et al., 1994), household interpurchase time (Vakratsas and Bass, 2002), interpurchase time in financial markets (Allenby et al., 1999), and length of the time that new movies stay on screens (Blumenthal, 1988).

Distributions that are used in duration analysis in economics include exponential (Kiefer, 1984; Diebold and Rudebusch, 1990), lognormal (Eckstein and Wolpin, 1995), gamma (Lancaster, 1979), and Weibull (Favero et al., 1994). The *GG* family, which encompasses exponential, gamma, and Weibull as subfamilies, and lognormal as a limiting distribution, has been used in economics by Jaggia (1991), Yamaguchi (1992), and Allenby et al. (1999). Some authors (e.g., Jaggia, 1991; Allenby et al., 1999) have argued that the flexibility of *GG* makes it suitable for duration analysis, while others have been using simpler models and avoiding the estimation difficulties caused by the complexity of *GG* parameter structure. Obviously, there would be no need to endure the costs associated with the application of a complex *GG* model if the data do not discriminate between the *GG* and members of its subfamilies, or if the fit of a simpler model to the data is as good as that for the complex *GG*. The question therefore is: Do the data necessitate use of a *GG* model? From the information theoretic perspective, this question is dealt with derivation of probability models based on partial information in the form of a set of constraints, measuring the incremental information content of additional constraints, and thereby assessing compatibility of models with the data. The *GG* information measures, presented in this paper, offer tools, with axiomatic basis and intuitive appeals, for *GG* as a general class of duration models.

The paper is organized as follows. Section 2 discusses information properties of the *GG* family and presents several discrimination information measures for the *GG* and its