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Serial correlation estimation through the imprecise Goal Programming model

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Abstract

The Goal Programming (GP) model was used as a time-series analysis tool that incorporates a Serial Correlation where the dependent variable is considered as precise. This formulation does not take into consideration the decision-maker's preferences. However, the dependent variable can be imprecise and its value can be expressed through an interval. The aim of this paper is to develop a new formulation of the GP model for regression with Serial Correlation where the dependent variable is imprecise. The proposed model will also integrate explicitly the decision-maker's preferences. A numerical example was used to illustrate our model.

Keywords: Imprecise Goal Programming; Autocorrelated error; Decision-maker's preferences

1. Introduction

Data in the form of time series arise in business, economics, and other areas of human activity. A time series is a sequence of observations measured over time (usually at equally spaced intervals; e.g. weekly, monthly, or annually). When error terms from different time periods are correlated, we say that the error term is serially correlated. However, the Serial Correlation has been the subject of many researches, and developments due to its widespread applicability.

Sueyoshi and Sekitani (1998) proposed Serial Correlation in the Goal Programming (GP) regression in order to deal with the problem of autocorrelated errors in time-series data. Many other academic researches

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proved that the use of the GP model as a statistical tool for estimation is better than conventional statistical methods, such as the Ordinary Least Squares method, and the Least Absolute Value method; Sueyoshi (1986), Charnes et al. (1986), Sueyoshi and Chang (1989), Aouni et al. (1997) and Aouni and Martel (2000).

The aim of this paper is to utilize the GP regression to introduce explicitly the Decision-Maker's (DM) preferences in the Serial Correlation model where the dependent variable is imprecise. We shall as a first step present estimation through the GP approach. Then, both imprecise dependent variables and DM's preferences will be incorporated explicitly in a GP model reformulation for regression with Serial Correlation.

2. Estimation through the GP model

The GP model is used as a statistical tool for estimation because it provides some advantages: is less sensitive to statistical conditions of multicollinearity or autocorrelation, is more stable in the presence of outliers, outperforms in the case of a smaller number of observations, does not require assumption concerning the data sets (such as the normality of errors), and finally, provides more flexibility for modelling the estimation process since the knowledge and the experiment of the analyst can be introduced into the constrains of the optimisation problem.

Among the numerous works in this area, we cite: "GP/Constrained Regression" (Sueyoshi, 1986), "GP Approach for Regression Median" (Sueyoshi and Chang, 1989), "Estimation through the Imprecise GP model" (Aouni et al., 1997), and "GP Regression with Serial Correlation" (Sueyoshi and Sekitani, 1998). In the following section, we will first present the Imprecise GP model, then the Sueyoshi and Sekitani (1998) model for estimating the Serial Correlation.

2.1. The GP model with intervals

In the literature we found that the first formulations of the GP with goals expressed through intervals were proposed by Charnes and Collomb (1972), Laurent (1976), Charnes et al. (1976) and Charnes and Cooper (1977). Later, Inuiguchi and Kume (1991) proposed a model where the coefficients and the goals were both expressed by intervals. In their paper, Inuiguchi and Kume (1991) presented four GP formulations: POS-LOW, POS-UPP, NES-LOW and NES-UPP, that differ according to the type of deviations (possible or necessary) and the type of decision process (optimistic or pessimistic). These formulations, favour central value of the intervals; In other words, the goals associated to various objectives were deterministic and equal to the central values to each interval (Martel and Aouni, 1996).

Aouni et al. (1997) formulated a GP model in which the goals belonged to an interval. In this formulation the decision-maker was indifferent to all solutions situated in the interval and DM's preferences were introduced explicitly referring to a previous paper of Martel and Aouni (1990). Their model can be expressed as follows:

$$\text{Program 1:}\quad \underset{x\in X}{\text{Maximize}} \quad Z=\sum_{t=1}^{n}\left(w_t^+F_t^+(\delta_t^+)+w_t^-F_t^-(\delta_t^-)\right)$$

$$\text{Subject to:}\quad \beta_0+\sum_{j=1}^{m}\beta_j x_{tj}-\delta_t^++\delta_t^-=\zeta_t;$$

$$Cx\leqslant c \text{ (System constraints)};$$

$$\delta_t^+\leqslant \alpha_{tv}^+ \text{ and } \delta_t^-\leqslant \alpha_{tv}^-;$$

$$\delta_t^+ \text{ and } \delta_t^-\geqslant 0 \ (t=1,2,\ldots,n);$$

$$\beta_0 \text{ and } \beta_j \text{ are free variables} \quad (\text{for } j=1,2,\ldots,m).$$