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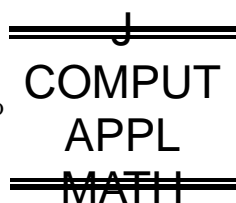
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# Application of a novel nonlinear multivariate grey Bernoulli model to predict the tourist income of China

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## Abstract

The nonlinear grey Bernoulli model, which is often called the NGBM(1, 1), appeals considerable interest of research due to its effectiveness in time series forecasting. The success of the NGBM(1, 1) model proves that the nonlinear Bernoulli equation can be efficient to build grey prediction models. This paper is mainly aiming at building a more general nonlinear grey prediction model based on the Bernoulli equation and the modelling procedures of the GMC(1, n), which is called the nonlinear grey Bernoulli multivariate model, abbreviated as the NGBMC(1, n). The NGBMC(1, n) can be converted to the NGBM(1, 1) and the GMC(1, n) with different power parameter, thus it can be regarded as an extension of these models. Two cases studies of forecasting the domestic income and foreign currency earning have been carried out to validate the effectiveness of the NGBMC(1, n) model, comparing to the novel linear multivariate grey models, including the GMC(1, n), DGM(1, n) and RDGM(1, n), and the classical ARIMA model. The advantages of the NGBMC(1, n) model in nonlinear time series forecasting over the existing linear models have been shown in the numerical results.

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*Keywords:* Bernoulli equation, Nonlinear grey model, NGBMC(1, n) model, Tourist industry, Emerging industry

## 1. Introduction

The grey system theory was proposed by Deng in 1982 [1], which is based on the idea of “Grey Box” and aiming at solving uncertain problems with small samples. The prediction models play an key role in the grey system theory, which are often called the grey models (GM).

The basic GM(1, 1) model is the most important grey model, which is easy to use and efficient in time series prediction, and it also represents the main idea of the methodology of the grey models. Numerous grey prediction models have been developed based on the similar methodology of the GM(1, 1) in recent years. Such as the NGM model [2], FGM(1, 1) [3], TDPGM(1, 1) [4], INDGM [5], seasonal GM(1, 1) [6], grey polynomial model [7], etc. However, Deng has pointed out that the GM(1, 1) presents a formulation with “partially differential and partially difference”. The “differential” means its whitening equation is a differential equation and its response function used for forecasting is the analytic solution of its whitening

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