

A FUNCTIONAL COEFFICIENTS NETWORK AUTOREGRESSIVE MODEL

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Abstract: The paper introduces a flexible model for the analysis of multivariate nonlinear time series data. The proposed Functional Coefficients Network Autoregressive (FCNAR) model considers the response of each node in the network to depend in a *nonlinear* fashion to each own past values (autoregressive component), as well as past values of each neighbor (network component). Key issues of model stability/stationarity, together with model parameter identifiability, estimation and inference are addressed for error processes that can be heavier than Gaussian for both fixed and growing number of network nodes. The performance of the estimators for the FCNAR model is assessed on synthetic data and the applicability of the model is illustrated on two data sets: the first on multiple indicators of air pollution data and the second on COVID-19 cases in Florida counties.

Key words and phrases: Functional-coefficient regression model, network autoregressive model, polynomial spline, ridge penalty.

1. Introduction

Nonlinear time series models gained prominence because of their ability to model, analyze and predict complex patterns in data in a wide range of fields, including economics and finance (Franses and van Dijk, 2000), climate (Donges et al., 2015), cognitive science (Ward, 2002), geosciences (Donner et al., 2008), and engineering (Zou et al., 2019). Departure from linearity opens different possibilities of developing nonlinear models. However, a fully nonparametric model that does not impose any constraints on the autoregressive form becomes harder to estimate with limited data or in a multivariate setting (Fan and Yao, 2003). Hence, the literature focused on specific classes of *parametric* nonlinear models for the *conditional mean* for *univariate* time series data, such as the exponential autoregressive (EXPAR) (Haggan and Ozaki, 1981), the threshold autoregressive (TAR) (Tong, 1990) and the smooth transition autoregressive models (Dijk, Teräsvirta and Franses, 2002) that added modeling flexibility. The Functional Coefficient Autoregressive Model (FAR) introduced by Chen and Tsay (1993) encompassed these other classes of models and ergodicity, estimation and inference issues were addressed. Follow-up work by Huang and Shen (2004),

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