Statistica Sinica **32** (2022), 2119-2146
doi:https://doi.org/10.5705/ss.202020.0383

SPATIOTEMPORAL AUTOREGRESSIVE PARTIALLY LINEAR VARYING COEFFICIENT MODELS

Shan Yu[1], Yueying Wang[2], Li Wang[3] and Lei Gao[3]

[1] *University of Virginia,* [2] *Columbia University and* [3] *George Mason University*

Abstract: With increasingly abundant data that relate to both space and time becoming available, spatiotemporal modeling is receiving much attention in the literature. This paper study develops a class of spatiotemporal autoregressive partially linear varying-coefficient models that are sufficiently flexible to simultaneously capture the spatiotemporal dependence and nonstationarity often encountered in practice. When spatial observations are observed over time and exhibit dynamic and nonstationary behaviors, our models become particularly useful. We develop a numerically stable and computationally efficient estimation procedure, using the tensor-product splines over triangular prisms to approximate the coefficient functions. The estimators of both the constant coefficients and the varying coefficients are consistent. We also show that the estimators of the constant coefficients are asymptotically normal, which enables us to construct confidence intervals and make inferences. The method's performance is evaluated using Monte Carlo experiments, and applied to model and forecast the spread of COVID-19 at the county level in the United States.

Key words and phrases: Partially linear models, penalized splines, semiparametric regression, spatiotemporal dependence, triangular prismatic partitions, varying coefficient models.

1. Introduction

The wide availability of data observed over time and space has stimulated studies in a variety of disciplines, such as economics, environmental science, epidemiology, and many areas of health studies. At the same time, spatiotemporal data are generated at scales and levels of complexity far beyond what could have been imagined previously. For example, there are many large-scale economic studies based on panels of data collected at the census tract, city, or county level with an implicit, but complex spatial structure. The observations in data can be regularly or irregularly distributed in space or time. Complex data call for

Corresponding author: Li Wang, Department of Statistics, George Mason University, Fairfax, VA 22030, USA. E-mail: lwang41@gmu.edu.