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Estimation for Semiparametric Nonlinear Regression of Irregularly Located Spatial Time-series Data

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Abstract

Large spatial time-series data with complex structures collected at irregularly spaced sampling locations are prevalent in a wide range of applications. However, econometric and statistical methodology for nonlinear modeling and analysis of such data remains rare. A semiparametric nonlinear regression is thus proposed for modelling nonlinear relationship between response and covariates, which is location-based and considers both temporal-lag and spatial-neighbouring effects, allowing data-generating process nonstationary over space (but turned into stationary series along time) while the sampling spatial grids can be irregular. A semiparametric method for estimation is also developed that is computationally feasible and thus enables application in practice. Asymptotic properties of the proposed estimators are established while numerical simulations are carried for comparisons between estimates before and after spatial smoothing. Empirical application to investigation of housing prices in relation to interest rates in the United States is demonstrated, with a nonlinear threshold structure identified.

Keywords: Irregularly spaced sampling locations; Large spatial time series data; Semiparametric spatio-temporal model and estimation; Spatial smoothing.

1. Introduction

Large amounts of spatial time-series data with complex structures collected at irregularly spaced sampling locations are prevalent in a wide range of disciplines such as economics, sociology, environmental sciences. For example, it is of economic interest to study the housing price in relation to other economic index, say interest rate, based on the available quarterly, state-level data collected in the United States (Figure 4). While there is a growing body of literature on statistical tools for analyzing spatial time-series data, most methods assume linearity and stationarity on the data-generating process (see, e.g., Cressie and Wikle (2011)), which may be violated in practice. This paper therefore aims to develop more effective econometric and statistical analytical techniques for modelling nonlinear relationship

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