

## NONLINEAR NETWORK AUTOREGRESSIVE MODEL WITH APPLICATION TO NATURAL GAS NETWORK FORECASTING

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Received June 22, 2020; revised June 24, 2020

**ABSTRACT.** We propose a nonlinear network autoregressive (NNAR) model to investigate the dynamics of complex network time series with high-dimensionality and nonlinear spatial-temporal dependence. We assume that the current network at a given time point non-linearly depends on the lagged values, neighborhood effect, and a set of node-specific covariates via a nonparametric smooth function. We conduct estimation using the profile least square method where the unknown link function is estimated using the local linear regression technique. We demonstrate the application of the NNAR with the daily natural gas flows in a real-life high-pressure gas pipeline network, where the response is the high dimensional vector of gas flows at 128 nodes. The NNAR model provides more accurate forecasts of the gas flow network compared to the linear network vector autoregression model proposed by [Zhu et al. \(2017\)](#) and some multivariate autoregression and naive benchmark models.

*Key words and phrases.* Network data; Nonlinear vector autoregression; Natural gas flows; Prediction.