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The impact of weight matrices on parameter estimation and inference: A case study of binary response using land-use data

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Abstract

This paper develops two new models and evaluates the impact of using different weight matrices on parameter estimates and inference in three distinct spatial specifications for discrete response. These specifications rely on a conventional, sparse, inverse-distance weight matrix for a spatial auto-regressive probit (SARP), a spatial autoregressive approach where the weight matrix includes an endogenous distance-decay parameter (SARPɑ), and a matrix exponential spatial specification for probit (MESSP). These are applied in a binary choice setting using both simulated data and parcel-level land-use data. Parameters of all models are estimated using Bayesian methods.

In simulated tests, adding a distance-decay parameter term to the spatial weight matrix improved the quality of estimation and inference, as reflected by a lower deviance information criteriaon (DIC) value, but the added sampling loop required to estimate the distance-decay parameter substantially increased computing times. In contrast, the MESSP model ’ s obvious advantage is its fast computing time, thanks to elimination of a log-determinant calculation for the weight matrix. In the model tests using actual land-use data, the MESSP approach emerged as the clear winner, in terms of fit and computing times. Results from all three models offer consistent interpretation of parameter estimates, with locations farther away from the regional central business district (CBD) and closer to roadways being more prone to (mostly residential) development (as expected). Again, the MESSP model offered the greatest computing-time savings benefits, but all three specifications yielded similar marginal effects estimates, showing how a focus on the spatial interactions and net (direct plus indirect) effects across observational units is more important than a focus on slope-parameter estimates when properly analyzing spatial data.

Keywords

Spatial autoregressive probit model, Matrix exponential spatial specification, Distance decay, Bayesian estimation, Land use change

Full Text:

PDF

DOI: http://dx.doi.org/10.5198/jtlu.v6i3.351

The Journal is housed at the University of Minnesota and sponsored by the Center for Transportation Studies

Contact JTLU | ISSN: 1938-7849

The Journal of Transport and Land Use is indexed in DOAJ, Google Scholar, and Scopus.