

# splm: econometric analysis of spatial panel data

Giovanni Millo<sup>1,2,\*</sup>, Gianfranco Piras<sup>3,4</sup>

1. DiSES, University of Trieste
  2. Generali Research and Development
  3. GeoDa Center, Arizona State University
  4. Universidad Catolica del Norte
- \* Contact author: giovanni.millo@generali.com

**Keywords:** Spatial Panels, ML, GM, Tests

We illustrate the new `splm` package, aimed at providing a comprehensive resource for spatial panel econometrics. The package fills a gap in applied practice, as the relevant estimators and tests are well established in the literature but to date they lack user-friendly and widely available software implementations.

Building on the infrastructure for spatially referenced data in package `spdep`, we provide estimators for the standard panel models in the spatial econometrics literature: fixed and random effects with either a spatial lag or spatial correlation in the error term, based on both the concurrent approaches prevailing in the literature, i.e. the Maximum Likelihood framework pioneered by Anselin (1988) and the Generalized Moments framework of Kapoor, Kelejian and Prucha (2007).

Some of the model estimation procedures are generalized to the case of spatially *and* serially correlated error terms. GM estimators for systems of equations are also available.

We also provide the Lagrange Multiplier joint, marginal and conditional specification tests from the work of Baltagi et al. (2003, 2007).

The user interface aims at consistency w.r.t. the spatial (non-panel) estimators in package `spdep` and the panel (non-spatial) estimators in package `plm`.

We briefly discuss code optimization aspects of the computationally heavy Maximum Likelihood routines that have up to now hindered the practical implementation of these estimators. The GM approach, on its part, yields very fast estimators that can be applied to comparatively big datasets.

We conclude with an empirical illustration on a well-known data set from the panel data literature.

## References

- Anselin, L. (1988). *Spatial Econometrics: Methods and Models*, Kluwer (UCSB)
- Kapoor, M., Kelejian, H. and Prucha, I. (2007). Panel Data Models with Spatially Correlated Error Components *Journal of Econometrics* 140, 97–130.
- Baltagi, B.H., Song, S.H., Jung, B.C. and Koh, W. (2003). Testing for Spatial Correlation, Serial Correlation and Random Effects using Panel Data *Journal of Econometrics* 140, 5–51.