



# Robust density power divergence estimates for panel data models

Abhijit Mandal<sup>1</sup> · Beste Hamiyi Beyaztas<sup>2</sup> · Soutir Bandyopadhyay<sup>3</sup>

Received: 5 February 2022 / Revised: 22 October 2022 / Accepted: 7 December 2022 /  
Published online: 20 January 2023  
© The Institute of Statistical Mathematics, Tokyo 2023

## Abstract

The panel data regression models have become one of the most widely applied statistical approaches in different fields of research, including social, behavioral, environmental sciences, and econometrics. However, traditional least-squares-based techniques frequently used for panel data models are vulnerable to the adverse effects of data contamination or outlying observations that may result in biased and inefficient estimates and misleading statistical inference. In this study, we propose a *minimum density power divergence* estimation procedure for panel data regression models with random effects to achieve robustness against outliers. The robustness, as well as the asymptotic properties of the proposed estimator, are rigorously established. The finite-sample properties of the proposed method are investigated through an extensive simulation study and an application to climate data in Oman. Our results demonstrate that the proposed estimator exhibits improved performance over some traditional and robust methods in the presence of data contamination.

**Keywords** Robust estimation · Minimum density power divergence · Panel data · Random-effect model

---

✉ Abhijit Mandal  
amandal@utep.edu

<sup>1</sup> Department of Mathematical Sciences, University of Texas at El Paso, 500 W. University Ave, El Paso, TX 79968, USA

<sup>2</sup> Department of Statistics, Istanbul Medeniyet University, Unalan Mahallesi, 34700 Uskudar, Istanbul, Turkey

<sup>3</sup> Department of Applied Mathematics and Statistics, Colorado School of Mines, 1500 Illinois St., Golden, CO 80401, USA