The Evolution of Panel Data Methods

From Fixed Effects to Machine Learning

1980s–1990s: Classical Panel Methods

Two-Way Fixed Effects
Mundlak (1978); Hausman & Taylor (1981)

Apps: Brand effects, Store heterogeneity

Random Effects / Within
Baltagi (1995); Wooldridge (2002)

Apps: Marketing mix, Customer panels

Design-Based Thinking

2000s: Design-Based Revolution

Synthetic Control
Abadie & Gardeazabal (2003); Abadie et al. (2010)

Apps: Market entry, Policy evaluation

Difference-in-Differences
Bertrand et al. (2004); Card & Krueger (1994)

Apps: Geo experiments, Rollout studies

Heterogeneity Awareness

2010s: Modern Methods & Heterogeneity

Interactive Fixed Effects
Bai (2009); Pesaran (2006)

Apps: Common shocks, Factor models

Staggered DiD
(Heterogeneity-Robust)

Callaway & Sant'Anna (2021); Sun & Abraham (2021)

Apps: Loyalty programs, Staggered rollouts

ML Integration

2020s: ML Integration

Synthetic DiD / Matrix Completion
Arkhangelsky et al. (2021); Athey et al. (2021)

Apps: Platform entry, Sparse panels

Double ML / High-Dim Controls
Chernozhukov et al. (2018); Belloni et al. (2017)

Apps: Rich covariates, Heterogentic effects