

Topic 6: DID and TWFE

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Key points: This note is on the causal panel data, building upon [Arkhangelsky and Imbens \(2023\)](#).

Disclaimer: *This note is compiled by Sai Zhang.*

6.1 Panel Data Configurations

6.1.1 Data Types

6.1.1.1 Panel Data

For observations on N units, indexed by $i = 1, \dots, N$, over T periods, indexed by $t = 1, \dots, T$, the outcome of interest is denoted by Y_{it} , the treatment W_{it} . These observations may themselves consist of averages over more basic units:

$$\mathbf{Y} = \begin{pmatrix} Y_{11} & \cdots & Y_{1T} \\ \vdots & \ddots & \vdots \\ Y_{N1} & \cdots & Y_{NT} \end{pmatrix} \quad \mathbf{W} = \begin{pmatrix} W_{11} & \cdots & W_{1T} \\ \vdots & \ddots & \vdots \\ W_{N1} & \cdots & W_{NT} \end{pmatrix}$$

we may also observe exogenous variables X_{it} or X_i . Typically, we focus on a balanced panel where for all units $i = 1, \dots, N$ we observe outcomes for all $t = 1, \dots, T$.

6.1.1.2 Grouped Repeated Cross-Section Data

In a GRCS data, we have observations on N units, each observed only once in period T_i for unit i . Different units may be observed at different points in time, T_i typically takes on only a few values, with many units sharing the same value for T_i . The outcome Y_i and treatment W_i are indexed by the unit index i . The set of units is **partitioned** into 2 or more groups, with the group that unit i belongs to denoted by $G_i \in \mathcal{G} = \{1, 2, \dots, G\}$.

Define the average outcomes for each group-time-period pair:

$$\bar{Y}_{gt} \equiv \frac{\sum_{i=1}^N \mathbf{1}_{G_i=g, T_i=t} Y_i}{\sum_{i=1}^N \mathbf{1}_{G_i=g, T_i=t}}$$

for treatment

$$\bar{W}_{gt} \equiv \frac{\sum_{i=1}^N \mathbf{1}_{G_i=g, T_i=t} W_i}{\sum_{i=1}^N \mathbf{1}_{G_i=g, T_i=t}}$$

then treat the $G \times T$ group averages \bar{Y}_{gt} and \bar{W}_{gt} as the unit of observation, then the grouped data is just a panel. The major issue in practice is that the number of groups is very small comparing to proper panel data.

6.1.2 Shapes of Data Frames**6.1.3 Assignment Mechanisms**

References

Dmitry Arkhangelsky and Guido Imbens. Causal models for longitudinal and panel data: A survey. Technical report, National Bureau of Economic Research, 2023.