# Synthetic Control Methods Step-by-Step Process

For full resource, see:  
<https://www.ncrm.ac.uk/resources/online/all/?id=20854>

**Step 1: Understand the Problem and Data**

1. Define the Research Question:
   * Identify the intervention (e.g., a policy change, treatment, or event) and the outcome of interest (e.g., GDP, crime rate, health outcomes).
   * Ensure the intervention is applied to a single unit (e.g., a country, state, or region) and that there are multiple untreated units (control units) available.
2. Gather Data:
   * Collect data on the outcome variable for both the treated unit and potential control units.
   * Include predictor variables (covariates) that influence the outcome and are measured before the intervention.
   * Ensure data is available for a sufficiently long pre-intervention period to construct a reliable synthetic control.

**Step 2: Prepare the Data**

1. Organise the Data:
   * Structure the data into a panel format, with rows representing units (treated and controls) and columns representing time periods and variables.
   * Ensure the treated unit and control units are clearly identified.
2. Check Data Quality:
   * Handle missing data (e.g., through imputation or exclusion).
   * Normalise or standardise variables if necessary.

**Step 3: Choose Control Units**

1. Select Potential Control Units:
   * Choose control units that are similar to the treated unit in terms of pre-intervention characteristics and outcomes.
   * Exclude units that may have been indirectly affected by the intervention.
2. Pre-Intervention Matching:
   * Ensure the synthetic control closely matches the treated unit in the pre-intervention period. This is critical for valid causal inference.

**Step 4: Construct the Synthetic Control**

1. Assign Weights to Control Units:
   * Use optimisation techniques to assign weights to control units such that the weighted combination of control units closely matches the treated unit in the pre-intervention period.
   * The weights should sum to 1 and be non-negative.
2. Optimisation Objective:
   * Minimise the difference between the treated unit and the synthetic control in terms of pre-intervention outcomes and covariates.
   * Common optimisation criteria include minimising the mean squared prediction error (MSPE).

**Step 5: Validate the Synthetic Control**

1. Check Pre-Intervention Fit:
   * Compare the pre-intervention outcomes of the treated unit and the synthetic control to ensure a close match.
   * Visualise the trends to assess the quality of the fit.
2. Conduct Placebo Tests:
   * Apply the synthetic control method to control units (placebo tests) to check if the method produces similar results for units that did not receive the intervention.
   * This helps rule out the possibility of spurious effects.

**Step 6: Estimate the Treatment Effect**

1. Compare Post-Intervention Outcomes:
   * Compare the post-intervention outcomes of the treated unit to the synthetic control.
   * The difference between the two represents the estimated treatment effect.
2. Visualise the Results:
   * Plot the outcomes of the treated unit and the synthetic control over time to visually assess the impact of the intervention.

**Step 7: Conduct Sensitivity Analysis**

1. Test Robustness:
   * Vary the set of control units or predictor variables to check if the results are robust to different specifications.
   * Use alternative methods (e.g., difference-in-differences) to validate the findings.
2. Assess Uncertainty:
   * Use statistical techniques (e.g., permutation tests) to assess the uncertainty of the estimated treatment effect.

**Step 8: Interpret and Report Results**

1. Interpret the Findings:
   * Discuss the magnitude and significance of the treatment effect.
   * Consider the practical implications of the results.
2. Report Limitations:

Acknowledge any limitations of the synthetic control method, such as reliance on pre-intervention fit or the availability of suitable control units.

National Centre for Research Methods (NCRM)  
Social Sciences  
Murray Building (Bldg 58)  
University of Southampton  
Southampton SO17 1BJ  
United Kingdom

**Web** www.ncrm.ac.uk   
**Email** info@ncrm.ac.uk  
**Tel** +44 23 8059 4539  
**Twitter** @NCRMUK