Synthetic Control Methodology as a tool for evaluating public health interventions – a literature review

**Introduction**

The synthetic control method (SCM) improves causal inference in non-randomised studies by building a counterfactual using a weighted combination of potential control units. Although it has been widely used in other disciplines it is not widely used in public health research.

**Objectives**

Our objectives were to identify the use of SCM studies in health and to summarise strengths and limitations identified in the literature.

**Methods**

We included studies that used a SCM design to investigate a health outcome of any intervention in any population. We searched for the term ‘synthetic control method’ in 26 health, social science and grey literature databases as well as checking for additional studies by key authors. No restrictions were placed on language or date. Searches were completed in February 2016. We summarised key information about the studies including setting, number of treated and control units, intervention and outcome, number of pre- and post-intervention data-points available and other methods used in the same study.

**Results**

- We identified 35 health-related studies of which 23 were from US settings and investigated a single treated unit.
- Most studies had at least 10 control units.
- Interventions investigated included health finance and health systems reform, industry regulation and taxation policies.
- Common outcomes were mortality rates and insurance rates/health care access.
- Most studies had more than 4 pre- and post-implementation data-points.
- SCM is most commonly used alongside difference-in-difference methods

**Advantages of SCM**

| Does not reply on parallel pre-implementation trends | Need suitable data for treated unit and pool of controls |
| Allows for time-varying unmeasured confounders | Difficult if the treated unit is an outlier |

**Limitations of SCM**

- Traditional statistical tests inappropriate – falsification tests are used as an alternative

**Conclusion**

This comprehensive literature review suggests that SCM has been little used in health despite some advantages over existing methods. Future research incorporating the method, ideally in combination with other methods, would be of value.

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**Figure 1: How SCM creates a counterfactual outcome time series**

What is the problem with comparing California tobacco sales to the rest of the US?
- Similar areas?
- Non-parallel trends pre-intervention
- Not reasonable to use whole of US as counterfactual

Solution: Take a pool of similar areas (here each of the US states) Match on predictor variables including outcome variables. Here the indicated states were weighted to match California.

Pre-intervention trend is a good fit between California and its synthetic control.

Gap between the actual and synthetic California tobacco sales is the estimated effect of the intervention.

Traditional statistical inference is not appropriate due to the small number of treated and control units and lack of randomisation.

Falsification tests can be used to improve inference. Here in a ‘placebo analysis’ each of the other states is used as the treated unit in the analysis. If the effect is larger for California than for any of the other states (as opposite) then causal inference is strengthened.

**Figures are taken with permission from Abadie, Alberto, Alex Diamand, and Jens Hainmueller. “Synthetic Control Methods For Comparative Case Studies: Estimating The Effect Of California’s Tobacco Control Program”. Journal of the American Statistical Association 105.490 (2010): 473-505**

**Figure 2: Discipline and setting of SCM studies identified in review**

**Figure 3: Exposures investigated and level of analysis of SCM studies identified in review**

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Peter Craig and Frank Popham are funded by the UK Medical Research Council (funding codes MC_UU_12_1713 and MC_UU_12_1715) and the Scottish Government Chief Scientist Office (funding codes SPHSU13 and SPHSU15)