Centre for the Evaluation of Complexity Across the Nexus

Note No. 6
Summer 2017

Dynamic pattern synthesis: a longitudinal method for exploring interventions in complex systems

A CECAN Evaluation and Policy Practice Note for policy analysts and evaluators

Dynamic pattern synthesis (DPS) is a mixed method that combines the advantages of two existing case based approaches: cluster analysis and qualitative comparative analysis. Typical samples of cases used are either sets of countries or organisations. For example, DPS can be used to compare how countries progress and compare with each other on a range of interconnected indicators.

DPS is a method that:

- Is longitudinal and is designed to examine case trajectories and the extent to which similarities and differences remain stable or become unstable over time. Therefore, it is interested in modelling convergence and divergence and observing where cases change cluster membership. This method is also used to identify persistent outliers and to theorise why they exist.
- Explores how cases change over time in relation to each other.
- Can assist policy evaluators, for example to define and better understand patterns of 'good' and 'bad' performance and how one case might make a change over time and move into a different cluster group.
- Allows for a multivariate measure of similarity and difference, whereas previous methods for attempting to understand case convergence have been rather dependent on a single dependent variable to provide the key definition of difference.
- Can make use of supportive descriptive and effect statistics where appropriate to help compare and contrast the trajectory of cases over time.

What are the main elements of Dynamic Pattern Synthesis?

The characteristic elements of DPS are that it:

- Works with small groups of cases, like its derivative methods, cluster analysis and qualitative comparative analysis. However, larger samples can also be researched, by sub-dividing the cases into groups of interest. For example, if studying and comparing all countries in the world, it would make sense to divide them into smaller groups, based on geography, or wealth, and then to explore these sub samples. DPS uses the qualitative approach of purposeful sampling rather than the quantitative and statistical approach of random sampling and making inferences to the population.
- Assumes that the cases studied in any sub sample are related in some way and have interactions, for example countries that trade with each other, or organisations operating in the same national market place.
- Combines explorative mathematical approaches to similarity employed by cluster analysis with theoretical simplification about the resulting cluster patterns found. The second theoretical stage uses qualitative comparative analysis to examine variable influences on clusters. This combined methods process is repeated over time to identify case and variable patterns that remain stable or change.

What key terms are commonly used in DPS?

Many of the technical terms used in DPS are derived from the methods of cluster analysis and qualitative comparative analysis.

A **Dendrogram** is a specific form of graph generated by cluster analysis that:

- Allows the researcher to see how many clusters are proposed by mathematical calculations of similarity and difference.
- Proposes a hierarchical cluster structure that the researcher must use to decide the level of cluster structure to investigate further. For example, with 18 cases, a dendrogram might initially propose three clusters with five members each and two outliers. At the next level it might suggest an amalgamation of one cluster with 10 cases and one with five, and two outliers. If the researcher decides to work with the greater amalgamation of cases, these later clusters will be less internally coherent in terms of case homogeneity. The greater the number of clusters analysed from a sample, the greater the degree of homogeneity within those clusters.

A **Truth Table** is a quantitative comparative analysis feature used In DPS that:

- Displays variable thresholds against the outcome of cluster memberships and theorises which variables are influencing specific cluster memberships.
- Can also be rearranged to propose another variable as an outcome. Cluster membership then becomes one of the explanatory variables.

Boolean simplification:

- Is used to summarise the variable characteristics of a cluster.
- Uses upper case characters indicate above threshold variable scores and lower case characters to indicate below threshold variable scores. For example, if the Boolean simplification of a cluster is **EMPLOYMENT *** inflation, this cluster has above average employment and below average inflation.

Prime implicant describes a threshold variable score that is shared by all cases in a given cluster. For example, if a cluster consists of Germany, France and Belgium and all share above median scores for the percentage of annual GDP growth, this variable is a prime implicant for that cluster.

A **Longitudinal Truth Table** is one that demonstrates which prime implicants remain consistent over time, using the periodic time points available in the research study. Case cluster structures in a longitudinal truth table may necessarily differ from those in a single cross sectional cluster truth table and this is an indication of the dynamic nature of the synthesis.

What are the essential features of DPS?

As a method of evaluation DPS:

Is dynamic – we can use DPS to observe how cases look in relation to each other and how this relationship constantly evolves and changes, and the degree of stability and instability in these relationships over time. Also, we can observe whether this dynamic is causing the convergence of cases or their divergence.

Identifies patterns – DPS searches for different patterns in the dataset and sees how these patterns evolve over time. Patterns may be case based, cases that are similar or different, or variable-related, that is showing which variables relate to a group of cases being similar at a given point in time. In addition, and most importantly, DPS allows the researcher to theorise about the relationship between variable and case patterns and how they evolve.

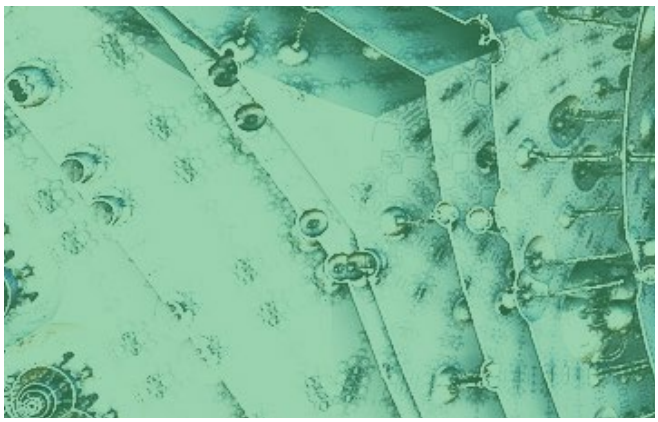
Emphasises synthesis – DPS puts the emphasis on synthesis rather than analysis. In other words, the method is considering change in a single case in relation to the overall change in the whole group of cases being studied. Any specific change is always understood in relation to what is happening in the other parts of that system of cases.

In what contexts can DPS be most usefully applied?

The method can usefully be applied in:

- Macroeconomics, comparative social and public policy, and comparisons of similar organisations (eg services, hospitals, schools).
- Circumstances where the researcher has access to a consistent interval or scale dataset over time and with a small number of relatively similar cases.
- Secondary and longitudinal datasets.
- Future applications need to explore concurrent investigations with qualitative studies of individual respondents






What advantages does DPS offer?

Dynamic Pattern Synthesis has advantages over both, cluster analysis and qualitative comparative analysis:

- DPS maximises the advantages of the two methods while minimising the weaknesses when they are used separately. Cluster analysis applies complex matrix measurement to a set of data, exploring possible case similarities and cluster structures. Next, qualitative comparative analysis provides the basis for checking the logic of any cluster structures proposed, and allows for analysing the detail of the relationship between variable scores and cluster formations.
- Repetition with the same dataset ensures that the method theorises social change over time and therefore assesses political, social and economic change against the irreversible dimension of time. This allows for the consideration of the impact of events: for example, how data patterns change after a particular event like an election or financial crisis.
- The qualitative comparative analysis and longitudinal qualitative comparative analysis element of DPS mean that it can easily be adjusted and re-run to model different possible outcome patterns, and to examine the consistency of a given outcome over time.
- DPS allows for careful consideration of the trajectory of individual cases. It is primarily a case based method and avoids the danger of making policy conclusions based on aggregate summaries of a large number of cases. As a method, it can identify aspects of equifinality (more than one pattern being associated with a given outcome), and multifinality (the same pattern resulting in different outcomes).

What are the drawbacks of using QCA?

Potential problems are:

- The concept of stability and instability over time will be relative to the specific situation being researched. In other words, there are no absolute measurements or boundaries of stability and instability when applying DPS. Pattern changes in any one sample are only relative to the cases in that particular dataset.
- The more time points that are included in the DPS, the less likely you are to find consistent prime implicants in the longitudinal truth table. If using many time points, you may want to exercise a qualitative judgement about whether a consistent long term pattern does exist, even if the threshold score is only consistent for a high proportion of occurrences, rather than all occurrences.
- Similarly, at a single time point, scrutiny of the QCA table for prime implicants can show up 'near misses', that is where one case in the cluster has a variable score that is marginally above or below the threshold point set, and this is preventing a conclusive judgement that the variable is a prime implicant. In this situation, the researcher can reasonably consider the distribution and central tendency of the related scores and make a qualitative decision that the variable is still a prime implicant for that cluster, at that point in time.

EXAMPLE | An evaluation of the implementation of the euro currency in the original member countries

Implementation of the euro single currency began in 2000 with full issue of paper currency in 2002. At the outset there were 12 core members of the currency. Key policy aims were to achieve low inflation across the 12 and also to seek the convergence of their economies and economic outcomes. The DPS examined the 12 countries. In another version of the DPS, new countries joining the euro (six new countries joined between 2006 and 2013) were also included, this to assess their impact on the overall dynamic euro environment.

Consistent economic data were available for modelling the impact. The specific data points compared were: (1) the launch of the currency, 2002, (2) the pre-crisis expansion of the periphery economies, 2006, and (3) the post crisis era, 2013.

Results showed:

- Inflation did converge across the 12 countries, but the financial crisis of 2008 suppressed overall demand in the Eurozone area.
- In other areas of economic performance, the combination of the new currency and the crisis, resulted in a divergence of the 12 countries.
- Despite considerable changes in the variables influencing cluster memberships, countries tended to stay in the same clusters, rather than changing in relation to each other.
- This suggests that national policies and trading interactions were influenced more by historical political and economic circumstances than by the single currency.
- Overall, the single euro currency failed to converge the economic performance of the 12 countries. This was caused by the financial crisis that disrupted the variable trends. For example, national long term interest rates and gross government debt diverged significantly after the 2008 crisis.

References and further information

Haynes, P. & Haynes, J. (2016) Convergence and Heterogeneity in Euro Based Economies: Stability and Dynamics. *Economies* 4:16: 1-16.

Haynes, P. (2015) The European Single Currency Project and the Concept of Convergence for European Welfare States – The Ideal and the Reality. *Social Policy and Administration* 49:4: 466-489.

Haynes, P. (2014) Combining the strengths of Qualitative Comparative Analysis (QCA) with Cluster Analysis for comparative public policy research: with reference to the policy of economic convergence in the Euro currency area. *International Journal of Public Administration* 37: 9: 581-590.

Haynes, P. (2012) *Public Policy beyond the Financial Crisis: An international comparative study*. Oxon: Routledge.

cecan
Centre for the Evaluation of Complexity Across the Nexus

www.cecan.ac.uk / cecan@surrey.ac.uk / +44 (0) 1483 682769

The Centre for the Evaluation of Complexity Across the Nexus (CECAN) is a £3m national research centre hosted by the University of Surrey, which brings together a unique coalition of experts to address some of the greatest issues in policy making and evaluation.

This Evaluation Policy and Practice Note was written by Professor Phil Haynes, University of Brighton. Contact: p.haynes@brighton.ac.uk.

E·S·R·C Economic & Social Research Council | Department for Environment Food & Rural Affairs | Department for Business, Energy & Industrial Strategy | NERC Science of the Environment | Environment Agency | Food Standards Agency food.gov.uk