QUALITATIVE COMPARATIVE ANALYSIS (QCA)

OVERVIEW

Qualitative Comparative Analysis (QCA) is a 'synthetic strategy' (Ragin, 1987, p. 84) that allows for multiple conjunctural causation across observed cases. This means that different (i.e. multiple) causal pathways can lead to the same result and that each pathway comprises a combination of conditions (i.e. they are conjunctural) (Berg-Schlosser et al., 2009). The method draws on the assumption that it is often the combination of multiple causes that has causal power (Befani, 2016). Furthermore, the same cause can have different effects depending on which other cause it is combined with and therefore lead to different outcomes. QCA builds on set theory to consider causal asymmetry and determine whether the conditions (or causes) are sufficient and/or necessary. QCA aims to achieve parsimonious (i.e. short) explanations whilst still accounting for causal complexity (Berg-Schlosser et al., 2009). It is deemed particularly relevant for dealing with complexity as it offers an alternative to traditional statistical methods that are often linear (Ott et al., 2018)

QCA is an iterative process where the researcher 'engages in a dialogue between cases and relevant theories' (Berg-Schlosser et al., 2009: 2). The technique is both deductive as the choice of variables (i.e. conditions and outcome) is theoretically driven and inductive as insights emerge from case knowledge (Rihoux, 2006; Rihoux & Lobe, 2009).

In QCA, each case is changed into a series of features, including some condition variables and one outcome variable (Berg-Schlosser et al., 2009). The method generally starts with a theory of change identifying 'conditions' (factors) that may contribute to the anticipated outcomes. QCA is an iterative process that requires in-depth knowledge of cases. It also requires data to have a certain granularity. For instance, it needs to include cases where the outcome was negative as well as positive. Similarly, the conditions need to include cases where the condition is present as well as cases where the condition is absent. Therefore, the quality and granularity of the data is paramount.

There are three main techniques: crisp set QCA (csQCA), fuzzy set (fzQCA), and multi-value QCA (mvQCA). They differ in how they code / consider membership of the cases. csQCA was initially developed drawing on Boolean logic. In csQCA, membership is dichotomous (e.g., 1= member, 0 = non member). However, its dichotomous nature is not always adapted to real life situations. fsQCA was developed in response to this limitation as a means to assign gradual values to conditions such as quality or satisfaction (Ragin, 2000). In fsQCA and mvQCA, membership is multichotomous and partial (e.g., 1 = full member, 0.8 strong but not full member, 0.3 = weak member, 0 = non member). Fuzzy set theory can be an interesting tool to capture the fuzzy nature of some conditions and allows for variance of the observations. It therefore overcomes one of the challenges of crisp set csQCA which entails a dichotomous analysis (Ott et al., 2018). However, csQCA allows for a more transparent process as calibration (i.e., setting of thresholds) are done manually and explained theoretically. In the case of fsQCA, thresholds are set by the programme at a later stage. Here we will focus on csQCA as a good introduction to the methodology.

Necessary and sufficient conditions

A cause is defined as necessary if it must be present for an outcome to occur (e.g., there must be a cloud for rain to occur). A cause is defined as sufficient if by itself it can produce a certain outcome (e.g., a cloud is NOT sufficient to know that it is raining, but rain is sufficient to know that there is a cloud). Necessity and sufficiency are usually considered together because all combinations of the two are meaningful:

- 'A cause is both necessary and sufficient if it is the only cause that produces an outcome and it is singular (that is, not a combination of causes).
- A cause is sufficient but not necessary if it is capable of producing the outcome but is not the only cause with this capability.
- A cause is necessary but not sufficient if it is capable of producing an outcome in combination with other causes and appears in all such combinations

- A cause is neither necessary nor sufficient if it appears only in a subset of the combinations of conditions that produce an outcome.'(Rihoux, 2017, p. 36)

There are different types of analysis that can be run to determine whether conditions are necessary (i.e., superset analysis), sufficient (i.e., subset analysis), or both (INUS analysis).

KEY ELEMENTS OF METHODOLOGY

Rihoux and De Meur (2009) identify steps for csQCA:

Step 1 Building a dichotomous data table

Drawing on the theory of change, data is coded for each condition and outcome in a dichotomous way (i.e., 1 = member, 2 = non-member). Thresholds need to be clearly justified and recorded when defining the presence and absence of conditions. This process of assigning numerical values to empirical manifestations of conditions is called calibration (Befani, 2006). Good practice for dichotomising conditions in a meaningful way can be found in Rioux and De Meur (2009, p. 41).

Step 2 Constructing a 'Truth Table'

Using software such as FsQCA or R, a first 'synthesis' of the raw data is produced in what is called a Truth table. This is a table of configurations (i.e., a number of combinations of conditions associated with a given outcome). The Truth table provides five types of configurations:

- Those with a [1] outcome
- Those with a [0] outcome
- Those with a '-' outcome, which means that the outcome is indeterminate
- Those with a 'C', which means there are contradictory outcomes (i.e. the configuration leads to a [1] outcome in some cases, but to a [0] outcome in other cases. These contradictions need to be resolved.
- Those with an 'L' or 'R' outcome, which are logical remainders (i.e., combinations that are theoretically possible but were not observed in empirical cases).

Figure 10: Example of Truth Table of the Boolean Configurations from Rihoux and De Meur (2009: 44)

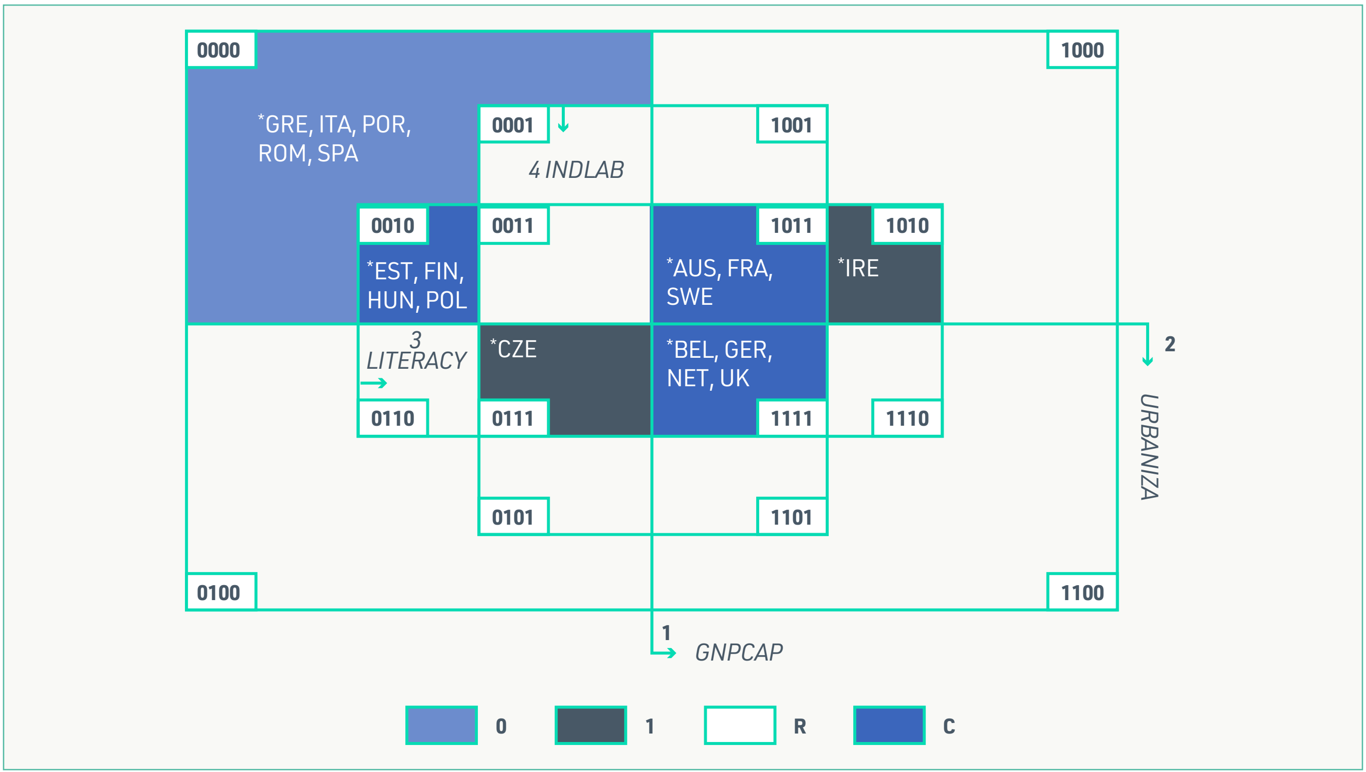
CASEID	GNPCAP	URBANIZA	LITERACY	INLAB	Survival
SWE. FRA. AUS	1	0	1	1	C
FIN. HUN. POL. EST	0	0	1	0	C
BEL. NET. UK. GER	1	1	1	1	C
CZE	0	1	1	1	1
ITA. ROM. POR. SPA. GRE	0	0	0	0	0
IRE	1	0	1	0	1

Step 3: Resolving Contradictory Configurations

Contradictory configurations are a normal part of QCA. This is when the reiterative dialogue between data and theory occurs. The evaluators need to resolve the contradictions through using knowledge of the cases and reconsider their theoretical perspective in order to obtain more coherent data. There are several ways to resolve contradictions, a simple one is to add conditions that may explain why a configuration then leads to a [1] outcome or [0] outcome. Other strategies include re-calibrating the way some conditions are operationalised. For example, moving the threshold of dichotomisation for a given contradiction may possibly resolve the contradiction. This process or recalibration is a normal part of QCA and supports the refinement of the theory underpinning the programme. Other strategies are also available, see Rihoux and De Meur (2009).

Venn diagrams (see Figure 11) provide a visualisation of cases' membership and non-membership. They are particularly useful to consider whether conditions are necessary or sufficient. It can also indicate which variable may need recoding to obtain a more parsimonious configuration.

Figure 11: Example of Venn Diagram produced by Tosmana software and corresponding to conditions in Figure 1 (Rihoux and De Meur, 2009, 46)



Step 4: Boolean Minimization

This step is usually completed by the software and synthesises the Truth Table. It identifies conditions that are either present or absent in configurations leading to the same outcome. As their presence or absence does not change the outcome, they are considered 'trivial' as they don't help evaluators discriminate between success and failure. They are therefore taken out to identify the shortest configuration possible.

First Boolean minimisation is applied to configurations with [1] outcome, then to those with [0] outcome and without including the logical remainders.

Step 5: Bringing in the 'Logical Remainders' Cases

Logical remainders constitute a pool of potential cases that can be used by the software to produce a shorter (i.e. more parsimonious) minimal formula. Through including hypothetical cases, the software can work broader categories of memberships and make 'simplifying assumptions'.

Similarly to the previous step, minimisation is applied to configurations with [1] outcome, then to those with [0] outcome.

Consistency and coverage

When running a Boolean minimisation, specialist software (e.g., Tosmana and fsQCA) calculate consistency and coverage for each configuration and for the solution as a whole. Consistency measures the degree to which the configuration is a subset of the outcome. Coverage measures how much the outcome is explained by each configuration (Rihoux, 2017).

MULTI-METHOD APPROACHES

Increasingly, evaluators are considering QCA as an exploratory method that is best used in combination with other methods. It can be integrated to statistical analysis to strengthen the theoretical contribution of the research (Meuer and Rupietta, 2017). According to Befani (2006), evaluation approaches based on Generative Causation such as QCA can be combined with:

- Systems-Based Evaluation: a holistic view of factors affecting the outcome, including feedback loops; might lend itself to simulation of complex dynamics.
- Realist Evaluation: to provide a magnifying lens on specific interactions in the causal chain or system. (e.g. a specific 'arrow'), or as a means to explore CMO (Context-Mechanism-Outcome) configuration.
- Contribution Analysis: to explore causal chains, with risks and assumptions for each pathway.
- Process tracing: used to generalise process tracing mechanisms. The combination of these two methods increases inferential value. QCA can be inform choices of cases in process tracing and process tracing findings can support better calibration (Schneider and Rohlfing, 2013).

As QCA and process tracing are becoming increasingly used together in multimethod studies, further guidance is emerging on their combination (see Álamos-Concha et al., 2021).

RESOURCES REQUIRED

Skill set for evaluators

QCA draws on Boolean algebra and set theory. The evaluator will therefore have to be quantitatively orientated. The method requires understanding the main conventions of Boolean algebra such as:

- An uppercase letter represents the [1] value for a given binary variable. Thus [A] is read as: 'variable A is large, present, high, ...'
- A lowercase letter represents the [0] value for a given binary variable. Thus [a] is read as: 'variable A is small, absent, low, ...'
- A dash symbol [–] represents the 'don't care' value for a given binary variable, meaning it can be either present (1) or absent (0). This also could be a value we don't know about (e.g., because it is irrelevant or the data is missing). It is not an intermediate value between [1] and [0].

Boolean algebra uses a few basic operators, the two chief ones being the following:

- Logical 'AND,' represented by the [*] (multiplication) symbol. NB: It can also be represented with the absence of a space: [A*B] can also be written as: [AB].
- Logical 'OR,' represented by the [+] (addition) symbol.

Beyond competencies, QCA is a method that works with a small number of cases but requires a large amount of information about these cases to inform calibration and resolve contradictions. It may not be appropriate for programmes where the understanding of cases is limited. It is also time consuming, especially if not familiar with the method. Whilst books and online resources are available, formal training will be recommended in most cases. QCA training is regularly available through the UK Evaluation Society and the Centre for Evaluation of Complexity Across the Nexus. They will usually offer a good introduction, geared towards evaluation work, in a one day workshop.

Furthermore, QCA is best conducted with the support of software. Most of them are available for free (such as R). Specialist software include:

- fsQCA freeware includes CRISP and FUZZY QCA.
- TOSMANA freeware is used for crisp-set QCA and for a multi-valued outcome QCA.

Resource implications

QCA can be run with a small number of cases, typically between 10 and 50. It is, however, the depth and quality of the data required to run the analysis that makes the method challenging. The iterative process between data and theory is time consuming. In some cases (i.e. where the evaluator does not have an in-depth knowledge of individual case), the process relies on the participation of external stakeholders. QCA analysis can be conducted alone, using a quality assurance checklist (see Befani, 2016: 182, Schneider and Wagemann, 2010), but collaborative work will provide opportunities to increase the quality of the evaluation. An evaluation using a QCA can take between three (if data is QCA ready) and six months (if data needs cleaning and clarifying). QCA relies on data being available on the outcome of choice. Therefore, the evaluation can take longer if this data is not available from the onset.

CASE STUDY

Bingham et al. (2019) used QCA to evaluate a university programme that employed an early alert intervention where students enrolled in courses could be alerted by their instructors or university staff if there was reason for concern. Instructors could alert students for various reasons, including attendance concerns, missing assignments, low quiz or test scores, in danger of failing, or cannot pass. Students enrolled in mathematics courses were included in this intervention and the analysis focused on these students. Bingham et al. used crisp-set QCA to explore the relationship between several input variables and one of two outcome variables: whether students passed their Fall semester maths course and whether they enrolled in courses for the following semester. The dichotomous input variables included in the analysis were whether students were 1st time freshmen, a fulltime student, used the University's Math Center, had an early alert meeting with the Program Coordinator, and enrolled in other maths courses. Observations were collected from the Fall semester sample of students who were alerted in their respective math courses. Truth tables were constructed of the cases associated with each outcome and the number of occurrences observed in the sample. Boolean equations were generated directly from the observed cases, using the truth table. Using csQCA allowed Bingham et al. to identify particular combinations of characteristics and behaviours that were associated with student success and retention, as well as what factors to take into account in considering the university policy on early alerts. The findings were holistic and provided a context for the interaction of the characteristics and behaviours of observed variables.

Reference

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RESOURCES

Web resources

Compasss is a website that specialises in QCA, listing events and providing extensive resources including a very comprehensive bibliography: https://compasss.org/

Ragin's (2017) User's Guide to fzQCA (2017) is a good starting point for fzQCA: https://www.socsci.uci.edu/~cragin/fsQCA/download/fsQCAManual.pdf

Key reading

A good introduction to QCA:

Befani, B. (2016) *Pathways to change: Evaluating development interventions with Qualitative Comparative Analysis* (QCA). Sztokholm: Expertgruppen för biståndsanalys (the Expert Group for Developent Analysis). Available at: https://eba.se/wp-content/uploads/2016/07/QCA_BarbaraBefani-201605.pdf

More in-depth books on QCA:

Rihoux, B. & De Meur, G. (2009) 'Crisp-Set Qualitative Comparative Analysis', in Rihoux, B. & Ragin, C.C. (Eds) *Configurational comparative methods: Qualitative comparative analysis (QCA) and related techniques*. Sage Publications.

Schneider, C. Q., & Wagemann, C. (2012) *Set-Theoretic Methods for the Social Sciences: A Guide to Qualitative Comparative Analysis*. Cambridge: Cambridge University Press.

Using R for QCA:

Oana, I.E., Schneider, C.Q. & Thomann, E. (2021) *Qualitative Comparative Analysis Using R: A Beginner's Guide*. Cambridge University Press.

Further references

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Rihoux, B., Álamos-Concha, P., & Lobe, B. (2021) 'Qualitative Comparative Analysis (QCA) An Integrative Approach Suited for Diverse Mixed Methods and Multimethod Research Strategies'. In A.J. Onwuegbuzie & R. B. Johnson (eds) *The Routledge Reviewer's Guide to Mixed Methods Analysis*, 185-195.

Rihoux, B., & Lobe, B. (2009) 'The case for qualitative comparative analysis (QCA): Adding leverage for thick cross-case comparison'. *The Sage handbook of case-based methods*, 222-242.

Rihoux, B., & De Meur, G. (2009) 'Crisp-Set Qualitative Comparative Analysis (csQCA)', in B. Rihoux, & C. C. Ragin (eds), *Configurational Comparative Methods: Qualitative Comparative Analysis (QCA) and Related Techniques*. Thousand Oaks and London: Sage.

Schneider, C.Q., & Rohlfing, I. (2013) 'Combining QCA and Process Tracing in Set-Theoretic Multi-Method Research'. *Sociological Methods & Research*. 42(4), 559-597.

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