

Set-Analytic Approaches, Especially Qualitative Comparative Analysis (QCA)

Final Report of QTD Working Group III.4

January 2019

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Introduction¹

Qualitative Comparative Analysis (QCA), introduced to the social sciences by Charles Ragin², is a formalized set-analytical method and approach for conducting systematic qualitative cross-case analysis. The goal of QCA is to identify (minimally) sufficient and necessary conditions for outcomes, and their derivatives: INUS and SUIN conditions.³ As Schneider and Wagemann note, “almost by default, QCA reveals conjunctural causation (i.e., conditions that do not work on their own, but have to be combined with one another); equifinality (where more than one conjunction produces the outcome in different cases); and asymmetry (where the complement of the phenomenon is explained in different ways than the phenomenon itself).”⁴ While still in development, QCA is increasingly applied in the social sciences – particularly in political science and sociology – and is turning into a “mainstream” approach.⁵ At the same time, QCA is also more and more criticized,⁶ though such studies have received their fair share of criticism in turn.⁷ More importantly for the present piece is that the criticism of QCA does not imply controversies over the general need for, and the form of, transparency. QCA is often depicted as both a research approach and a data analysis technique.⁸ Transparency issues that arise during the QCA-as-an-approach phase of research – e.g., the collection of data, the construction and selection of cases, and the specification of the universe of cases – are similar to issues in non-QCA qualitative research. Conversely, transparency issues that arise during the QCA-as-a-technique phase of research – the computer-based analysis of a truth table – are similar to issues in quantitative research. Though transparency criteria related to QCA-as-an-approach seem less well developed and more contested, they are not unique to QCA, and we refer to the other QTD-working groups’ reports for a discussion of these aspects.⁹ So this report focuses on QCA as an analytic technique.

As a data analysis technique, however, what sets QCA apart from almost all other qualitative methods is the computer-based analysis of a truth table – the “algorithmic-analytic” part. In this report, we therefore focus especially on the transparency issues that arise in the technique – that is, the algorithmic-analytic phase of QCA. By and large, many, if not most, transparency issues related to QCA-as-a-technique¹⁰ are uncontested and a lot of progress has been made in recent years on this front. In a way, the analysis of the truth table by means of software is not so different from the “analytical moment” in statistical analysis, meaning that while the issues that warrant addressing differ, transparency can likely be achieved in much the same way.

In this report, we make use of the rich and constructive online discussion on transparency in QCA that took place on the Qualitative Transparency Deliberations (QTD)

¹ We thank Tim Büthe, Alan Jacobs, and the participants of the QTD online discussions for their helpful and constructive comments on earlier versions of this report.

² Ragin 1987, 2000, 2008; see also Rihoux & Ragin 2009; Schneider & Wagemann 2012.

³ ‘INUS stands for “Insufficient but Necessary part of a condition which is itself Unnecessary but Sufficient for the result” (Mackie 1965, 246). SUIN stands for “Sufficient but Unnecessary part of a factor that is Insufficient but Necessary for the result” (Mahoney, Kimball, and Koivu 2009, 126).’

⁴ Schneider and Wagemann 2012, 78ff.

⁵ Rihoux et al. 2013.

⁶ e.g., Lucas & Szatrowski 2014; Paine 2016.

⁷ e.g., Fiss, Marx, & Rihoux 2014; Ragin 2014; Schneider 2016; Thiem & Baumgartner 2016.

⁸ e.g., Rihoux & Ragin 2009; Schneider & Wagemann 2012; Wagemann & Schneider 2010.

⁹ This includes, for instance, working groups on research ethics, text-based sources, evidence from researcher interactions with human participants, and non-automated content analysis.

¹⁰ Because the report focuses on QCA-as-a-technique, for the sake of simplicity we will henceforth refer to “QCA-as-a-technique” as “QCA.” Virtually all of the transparency requirements we identify equally apply to Coincidence Analysis (Baumgartner, 2009).

website.¹¹ We ourselves did not (or did only moderately) intervene into the discussion. Once the forum was closed, we carefully analyzed the contributions and identified recurrent themes and suggestions. Those topics that were not strictly related to transparency issues vis-à-vis set-methods are not included in this report. Additionally, we make extensive use of our own research experience and the existing literature on QCA, whereby we take Wagemann and Schneider's (2015) article on transparency in QCA as our starting point.

1. Meaning and Conceptualization of Transparency in QCA

What does it mean to be transparent about research?

We agree with Büthe & Jacobs that being transparent about research means “providing a clear and reliable account of the sources and content of the ideas and information on which a scholar has drawn in conducting her research, as well as a clear and explicit account of how she has gone about the analysis to arrive at the inferences and conclusions presented – and supplying this account as part of (or directly linked to) any scholarly research publication.”¹² Adopting this definition by no means implies that transparency is the only or the most important issue for social scientific research; it is an important issue, which can be in a trade-off relation with other important goals.

About what aspects of the QCA research process or its outcomes might scholars seek to be transparent?

Broadly speaking, many of the issues researchers might be transparent, or open, about when conducting QCA do not differ from other qualitative (and to a large extent also quantitative) techniques. Here we introduce these issues at an abstract level; in section 4 we discuss them in more detail.

- An issue that likely relates more to QCA-as-an-approach than to QCA-as-a-technique that we concentrate on here is transparency about where the data came from and how that data was coded.
- More specific to QCA-as-a-technique is how researchers subsequently calibrated the “raw” data into crisp, fuzzy, or multi-value sets to be used in QCA.
- With respect to the analysis itself, researchers need to be transparent about which specific analytical choices they made and why (e.g., the consistency and frequency thresholds).
- Regarding the results, researchers need to be comprehensive yet as concise as possible in presenting them.
- They also need to link their cases to these results, present the robustness tests they have conducted and, finally,
- Discuss to what extent these different analytical choices influence the results.

To whom might scholars want to be transparent about these things?

The audiences to whom QCA-researchers might want to be transparent about the issues listed above are diverse and not all transparency issues apply equally to all audiences. A – possibly non-exhaustive – list includes:

¹¹ See <https://www.qualtd.net/>.

¹² Büthe & Jacobs 2015, 2.

- Readers of QCA-based research;
- Reviewers of QCA-based manuscripts;
- Journals editors;
- Methodologists;
- QCA software developers.

2. Assessment of Benefits of Transparency in QCA

The potential benefits of being transparent about the issues mentioned in the previous section and discussed in more detail in Section 3a under (a) through (h) are high, with dividends paid to the QCA research community, other, non-QCA researchers, and QCA as a technique itself. In all cases, QCA researchers that adhere to these transparency guidelines provide other researchers (including critics, reviewers, and editors) with enough material at hand to evaluate whether the research has been conducted properly and whether there are other, equally plausible analytic decisions that could be made. Reporting and discussing these matters provides openness about what researchers have done, and why. All this facilitates the further development and improvement of QCA-as-a-technique.

There are five main benefits to this openness: interpretability, replicability, clarity, articulation, and methodological development. We will discuss each in turn.

(1) Transparency enables the *interpretability of the study's findings*. Openness about how a researcher went about arriving at his or her conclusion can be invaluable help in “making sense” of the results obtained.

(2) Openness allows for *replication* of the study, which aids evaluation. In line with our focus on QCA-as-a-technique, we limit the notion of replication to the reanalysis of the original data. In Section 4, we discuss several ways in which the benefit of replicability can be obtained (for example, by making available the script of a QCA analysis).

(3) Transparency or openness compels researchers to clearly communicate their research more generally, achieving another goal of research – *clarity*. Transparency concerning the calibration of raw data, the assumptions made in regard to the truth table analysis, the robustness checks conducted, et cetera, compels researchers to be clear about the conceptualization of various components of the research project, improving communication of their research in the process.

(4) Transparency or openness can contribute to the *articulation* of QCA itself. Being a young technique that is still not well and widely known – and contested among some social scientists (see Section 1) – QCA as a method stands to profit from transparent applications that enable everyone to better understand how the method works when applied to real data.

(5) For those interested in further developing, improving, and/or teaching QCA as a method (course instructors and software developers), openness in applied QCA provides valuable material.

Still, let us reiterate here that transparency is a means towards an end. We agree with Hall that “in its various dimensions, transparency is a means toward [research that reflects an honest and systematic search for truths about society, the economy, or politics]. But it is only

one of several such means and, like most of them, its various modalities come laden with trade-offs.”¹³

3. Practices and Models of Transparency in QCA

How can researchers go about pursuing transparency in their QCA studies along the lines we identified before?

3a. *What are valued current practices of transparency in QCA?*

There is wide agreement in the QCA-community that all QCA-studies should be transparent about a series of points, which we list below under (a) through (h). All these points contribute to the five benefits mentioned above (interpretability, replication and evaluation, clarity, refinement, and development).

QCA-studies should be transparent about:

(a) ***The “raw” data that are used.*** These data can be included in an (online) appendix, preferably in a machine-readable format in the case of standardized raw (or calibrated) data.

(b) ***The way these “raw” data are calibrated into crisp, fuzzy, or multi-value sets.*** The crucial information to be provided here is where the qualitative anchors have been placed – in particular the 0.5 anchor – and why that decision has been made. Without this information, especially the interpretation, replication, and clarity of the study are hampered. Therefore, this information should be included in the main text.

(c) ***The resulting membership scores of cases in sets.*** Oftentimes, it will suffice to include these data also in an (online) appendix, again preferably in a machine-readable format.

(d) ***The truth table that is derived from the calibrated data,*** and

(e) ***The choices made with respect to the truth table analysis,*** such as the cut-offs chosen for case frequency and consistency of each row and the assumptions on logical remainders that have been made. There are three decisions researchers should be transparent about relating to the truth table and its logical minimization:

(1) *How consistent the empirical evidence needs to be for a row to be considered sufficient for the outcome,* that is, where to set the cut-off point for raw consistency (consistency of a truth table row). Researchers should be clear about the guiding decision here – namely, whether the cases that are inconsistent with the statement of sufficiency are deviant cases in degree or kind. The latter are cases whose fuzzy set membership score in the condition X not only exceeds that in the outcome Y, but whose membership in X is bigger than 0.5 and in Y smaller than 0.5.¹⁴ Further information beyond consistency should be gathered, such as the issue of simultaneous subset relations, that is one and the same set (e.g., truth table row) passing the consistency threshold for both the outcome and its negation. Therefore, the PRI value – which provides a measure to assess this phenomenon, which can only occur with fuzzy sets and not with crisp sets – should always be reported, too. These practices contribute both to the interpretability of the results and – by demonstrating how these decisions are made regarding real data – to improving the articulation of QCA for the social science research community.

¹³ Hall 2016, 32.

¹⁴ Schneider & Rohlfing 2013.

(2) *The frequency cut-off* – that is to say, the minimum number of cases that are needed for a truth table row not to be considered as a logical remainder row. While most applied QCA sets this frequency threshold to 1, there are plausible scenarios of (larger-N) QCA in which this threshold could, and perhaps should, be higher. Reporting the frequency cut-off improves the replicability of the research.

(3) *How the researcher has treated the so-called logical remainders*, that is, those logically possible combinations of conditions for which there are no empirical cases (empty truth table rows). A researcher's choice influences the solution formula obtained, usually labeled as complex or conservative (no simplifying assumptions on remainders), most parsimonious (all simplifying assumptions), and intermediate solution (only "easy" simplifying assumptions).¹⁵ When making use of simplifying assumptions, researchers should always indicate explicitly why the simplifying assumptions used are warranted. Without this information, it is "difficult, if not impossible, for the reader to gauge whether the QCA results are based on difficult,¹⁶ unwarranted, or even untenable assumptions.¹⁷ Untenable assumptions run counter to common sense or logically contradict each other."¹⁸ Along the same lines, researchers should also report explicitly the so-called directional expectations or arguments behind the assumptions made. Wagemann & Schneider stress "(...) that lack of transparency in the use of logical remainders not only runs counter to transparency standards, but also leaves under-used one of QCA's main comparative advantages: the opportunity to make specific decisions about assumptions that have to be made whenever the data at hand are limited in their diversity."¹⁹ Researchers should be explicit about why the type of solution (conservative, most parsimonious, intermediate) selected is suitable for the research goal at hand. This practice contributes to the replicability, interpretability, and clarity of the research and the development and teaching of QCA.

(f) *The parameters of fit of the solution formula obtained*. These should be reported in the main text, including the solution formulas themselves, expressed in Boolean notation.

(g) *The cases covered by each solution term, the cases that contradict each term, and the cases that remain unexplained by the entire solution formula*. If space constraints allow it, this information can be provided in the main text. Otherwise, it can be reported in an (online) appendix. This information greatly facilitates the combination of QCA with follow-up case studies and as such provides an invaluable tool for integrating QCA-as-a-technique with QCA-as-an-approach.

(h) *The robustness tests that have been conducted*. The importance of reporting the robustness tests that have been conducted is an issue that most QCA-researchers agree on, as well as that conducting such tests is important in the first place. Obviously, robustness tests can be assessed only when researchers report them and are transparent about them. What the appropriate robustness tests for a "typical" QCA are is less obvious, though, since QCA-applications vary widely in terms of, for instance, the number of cases included, the type of data, the researcher's knowledge of the cases, et cetera. All these factors influence which robustness tests are or are not useful to conduct.²⁰ In general, we agree with Wagemann & Schneider that the crucial point of robustness tests is "to demonstrate that equally plausible

¹⁵ Baumgartner & Thiem 2017; Ragin 2008, 147ff; Schneider & Wagemann 2012, 167ff.

¹⁶ Ragin 2008, 147ff.

¹⁷ Schneider & Wagemann 2012, 198.

¹⁸ Wagemann & Schneider 2015, 40.

¹⁹ Wagemann & Schneider 2015, 40.

²⁰ See e.g., Baumgartner & Thiem 2017; Thiem, Spöhel, & Duşa 2016; Wagemann & Schneider 2015.

analytic decisions would not lead to substantively different results.”²¹ Whether the appropriate robustness tests have been conducted is a matter for debate, and cannot be codified in transparency guidelines. We only argue that robustness tests ought to be conducted and faithfully reported.

We also concur that a meaningful robustness test is a transparent one that stays “true to the fundamental principles and nature of set-theoretic methods and thus cannot be a mere copy of robustness tests known to standard quantitative techniques.”²² Depending on, among other factors, the type of data used and the researchers’ knowledge of the cases, relevant robustness tests for QCA may include the following: assessing the effect of changes in the calibration of the conditions and/or the outcome (e.g., different qualitative breakpoints or functional forms); or in the raw consistency levels, examining what happens when cases or conditions are added or dropped.²³ Researchers should report, preferably in an (online) appendix, what are “the effects, if any, of different analytic choices on the results obtained.”²⁴ We want to stress that while the results of the robustness tests can thus be presented in (online) appendices, the researcher must include a summary of these results in the main text, too. By performing and reporting robustness tests, researchers reap all of the five benefits mentioned above.

3b. What are low-cost improvements of transparency in QCA?

There are also some issues about which it is less common to be transparent, but which do warrant transparency and where this transparency can be achieved at minimal cost.

- Provide the script used in the analysis. The benefit hereof is two-fold: it allows others to evaluate a study’s analysis and it enables other researchers to take the (raw) data and replicate all analytic steps of the analysis.
 - If a command-line software such as R is used, the script consists of a list of commands, which should be accompanied by comments explaining each analytic step and information on which package R package version (and operating system) have been used. Most QCA-researchers using R already provide such scripts.
 - For the majority of QCA-researchers that use graphical user interface (GUI) software, the ‘script’ can instead consist of a series of screenshots and verbal description of the steps taken. Providing this material is needed to allow for easy replicability of a study.
- Report software package used (including the version number). With the increasing number of available packages to conduct QCA analyses this is becoming ever more important, especially since some packages vary in the algorithm used to minimize the truth table and in their default settings for crucial operations, such as calibration and logical minimization.²⁵
- Report model ambiguity. For one and the same truth table, there can be multiple logically equivalent solution formulas. Even though these formulas are *logically*

²¹ Wagemann & Schneider 2015, 41.

²² Wagemann & Schneider 2015, 41; see also Baumgartner & Thiem 2017.

²³ See, e.g., Baumgartner & Thiem 2015; De Block & Vis 2018; Marx 2010; Skaaning 2011; Thiem et al. 2016.

²⁴ Wagemann & Schneider 2015, 41.

²⁵ Referencing software packages also gives credit to the enormous amount of time software developers spend on developing (open access) packages, without which QCA could not be conducted. In this report, we do not discuss the issue of whether and how software developers should be transparent in all regards (for instance, by keeping a log of all changes that are made from one version to the next).

equivalent, the *substantive* implications a researcher draws from them can differ. Baumgartner and Thiem (2015) show that the phenomenon of model ambiguity is probably more common in applied QCA than currently recognized, partly because researchers tend to not report model ambiguity. We agree with Wagemann & Schneider that “transparency dictates (...) that researchers report all different logically equivalent solution formulas, especially in light of the fact that there is not (yet) any principled argument based on which one of these solutions should be preferred for substantive interpretation.”²⁶ All this requires that software and software settings are chosen such that all possible solution formulas are revealed.

- Improve transparency regarding the analysis of necessity. Regarding the analysis of necessity there is something to be gained in terms of transparency. If researchers postulate a specific set (be it a single condition, a disjunction, or conjunction) as necessary for the outcome, then all other minimal supersets of that outcome that pass the researcher’s empirical test criteria (consistency, relevance) should be reported and arguments be provided as to why those other minimal supersets are not interpreted as necessary conditions.²⁷
- Be transparent about the process of “going back and forth between theory and evidence.”²⁸ This low-cost improvement regarding transparency in QCA is an issue that is at the border between QCA-as-an-approach and QCA-as-a-technique. As Wagemann & Schneider indicate, “there is nothing bad nor unusual about updating beliefs and analytic decisions during the research process – as long, of course, as this is not sold to the reader as a deductive theory-testing story.”²⁹ This process becomes problematic when it is unclear what key decisions that substantively influence the study’s findings have been taken by a researcher. The challenge here is “figuring out how scholars can be explicit about the multi-stage process that led to their results without providing a diary-like account.”³⁰ The specific choices that are relevant to report vary from study to study but these are some of the pieces of information that may be worth reporting in many QCA-based studies:
 - The initial theoretical hunches, if a researcher starts from such hunches.
 - How the empirical information gathered has altered these initial theoretical hunches.
 - Why the initial case selection was changed due to empirical knowledge gained throughout the analysis.
 - Why initial conditions were dropped, integrated into “super conditions”, or why new conditions were added.

Note that it, of course, does not add to transparency if researchers summarize the research process by turning it upside down pretending that they started with complex (equifinal and conjunctural) hypotheses that are then ‘tested’ with, and confirmed by, their QCA. If anything, such a misrepresentation of the study’s purpose and design undermines transparency (see Section 3a).

²⁶ Wagemann & Schneider 2015, 41.

²⁷ On analyzing necessary conditions in QCA, see Bol & Luppi 2013; Schneider, 2018.

²⁸ Ragin, 1987, 2000.

²⁹ Wagemann & Schneider 2015, 39.

³⁰ Wagemann & Schneider 2015, 39.

3c. *What are practices for cautious assessment or selective use regarding transparency in QCA?*

The possible drawbacks of transparency in QCA depend to a large extent on the type of data used in the analysis. If these are quantitative data, the costs are comparable to those of traditional statistical analysis and thus not that large.³¹ If these data are mainly qualitative, or a combination of quantitative and qualitative data, the costs are much higher.³² The latter, however, is not specific to QCA-as-a-technique. When the data used for QCA are qualitative, researchers should proceed with caution in making that data available, taking into consideration ethical, proprietary, and logistical concerns. Here we refer QCA researchers to the best practices delineated in the appropriate QTD-working group reports, particularly the groups on Text-Based Sources and on Evidence from Researcher Interactions with Human Participants.

3d. *What are inadvisable practices regarding transparency in QCA?*

Inadvisable practices regarding transparency in QCA revolve largely around those that would introduce more information at the expense of transparency. There is a danger that transparency standards become so extensive that, paradoxically, they contribute to non-transparency. This could happen, if, for instance, appendices become too long and thus difficult to identify the main points. Producing hundreds of different QCA solution formulas without condensing or interpreting what they show would certainly not contribute to transparency. Therefore, researchers should always include in the main text a summary of the material in an (online) appendix.

QCA researchers should not pretend that they engaged in hypothesis testing when they followed the ‘dialogue between ideas and evidence’ approach to QCA.

Unless it is the explicit analytic goal of the researcher to compare the different QCA solution formulas, (conservative, intermediate, most parsimonious), only one should be used for substantive interpretation, not all of them.

- *Can a researcher discuss calibration in sufficient detail if they cannot make their data available?*

Generally, it is advisable to use examples from the data to demonstrate how the raw data was calibrated into the sets used for algorithmic analysis. However, some raw data cannot be discussed in such detail. This constraint holds especially for qualitative data (such as material from archives, interviews, or observations), as there may be privacy, proprietary, or logistical considerations that prevent the researcher from making the data public (see Section 3c). Though these considerations may inhibit making such data publicly available, researchers could still discuss how they went about collecting them and what the data entail. For QCA studies using qualitative data, it is possible to indicate in general terms how the data have been calibrated. One way to do so would be to use a fictitious example to this effect instead of the regularly used examples from the real data.³³

4. Discussion

All of the above listed points (a to h) seem uncontested and thus qualify as best “practices” – in this case regarding transparency in QCA – in the sense of “(...) transitory condensations of

³¹ Hall 2016.

³² Hall 2016.

³³ On how to calibrate qualitative data for QCA, see Basurto & Speer 2012; Tóth et al. 2017; and De Block & Vis 2018 for a discussion.

a shared understanding that are valid until improved.”³⁴ Any given QCA-study will be able to put more emphasis and energy on some of the transparency or openness requirements than on others, but the consensus seems to be that all of them should be addressed to a minimum degree by all published QCA.

There are at least two issues that are contested in QCA more generally – the treatment of logical remainders and the analysis of necessity – but these issues do not influence how researchers should deal with transparency in QCA.³⁵ In terms of transparency or openness, there is little to no substantial disagreement in the QCA-community. Adhering to the guidelines discussed above should improve interpretability, replicability, clarity, articulation, and methodological development to the benefit of journals editors, QCA software developers, methodologists, as well as producers and consumers of QCA-based research.

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³⁴ Wagemann & Schneider 2015, 38.

³⁵ The first contested issue is the treatment of logical remainders. While some scholars argue that researchers are free to choose between the conservative, intermediate, and the most parsimonious solution, others claim that only the latter is eligible, for only the most parsimonious solution can be interpreted in causal terms. Second, and relatedly, the majority of QCA-researchers perform separate analyses of necessary conditions and of sufficient conditions. Some scholars argue, instead, that only the most parsimonious solution is needed because the minimally sufficient conjunctions form a minimally necessary disjunction – that is, the most parsimonious solution formula as a whole constitutes a necessary condition.

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