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

Draft Report of QTD Working Group III.4

14 July 2017

Working group members

Carsten Schneider, Central European University <schneiderc@ceu.edu>
Barbara Vis, Vrije Universiteit Amsterdam & Utrecht University <b.vis@vu.nl>
Kendra Koivu, University of New Mexico <klkoivu@unm.edu>

Qualitative Comparative Analysis (QCA), introduced to the social sciences by Charles Ragin (Ragin, 1987, 2000, 2008; see also Rihoux & Ragin, 2009; Schneider & Wagemann, 2012) is the most 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 derivates: INUS and SUIN conditions.[1] As Schneider and Wagemann (2012: 78ff) 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). 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 (Rihoux et al. 2013). At the same time, QCA is also more and more criticized (e.g., Lucas & Szatrowski, 2014; Paine, 2016), though such studies have received their fair share of criticism in turn (e.g., Fiss et al., 2014; Ragin, 2014; Thiem & Baumgartner, 2016). 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* (e.g., Rihoux & Ragin, 2009; Schneider & Wagemann, 2012; Wagemann & Schneider, 2010). 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

[1] '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).' (Wagemann & Schneider, 2015: 38, note 4).

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.[2]

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-technique[3] 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 discussion on transparency in QCA that took place in, especially, Stage 2 of the Qualitative Transparency Deliberations (QTD) – a discussion board for this Working Group that was open for comments from September 2016 till January 2017. Additionally, we make extensive use of 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 (2015: 2) 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.' 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.

---

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

3 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 (cna, Baumgartner, 2009).

About what aspects of the QCA research process or its outcomes might scholars potentially 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 relates probably more to QCA-as-an-approach is transparency about where their 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 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:

- 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 4 under (a) through (i) are high, with dividends paid to the QCA research community, other 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. 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.

We think that there are five main benefits to this openness: interpretability, replicability, clarity, articulation, and methodological development. We will discuss each in turn. First, transparency enables the interpretability of the study's findings. While this is probably of interest to all researchers, we think it might be particularly relevant for those researchers who are accustomed to qualitative work. For these researchers, a study's findings need to "make sense" and openness about how a researcher went about arriving at his or her conclusion can be invaluable help in this regard. Second, openness allows for replication of the study. This may be particularly relevant for those researchers who are accustomed to quantitative work, in which replication of findings is usually straightforward. 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).

Third, transparency compels researchers to clearly communicate their research more generally, complementing 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. Fourth, transparency 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. Fifth, for those interested in further developing, improving, and/or teaching QCA as a method, openness in applied QCA provides valuable material.

Still, let us reiterate here that transparency is a means towards an end, namely research that reflects an honest and systematic search for truths about society, the economy, or politics. This means we agree with for instance Hall's (2016: 32) statement 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.'

3. Assessment of costs, risks, appropriateness, and constraints of transparency in QCA

The costs, risks, appropriateness, and constraints 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 et cetera are comparable to those of traditional statistical analysis and thus not that large (Hall, 2016). If these data are mainly qualitative, or a combination of quantitative and qualitative data, the costs et cetera are much higher (Hall, 2016). The latter, however, is not specific to QCA-as-a-technique.

Let us mention two concerns here, and how researchers might still be transparent or open about them.

- *Can a researcher make his or her data publicly available and/or discuss calibration in sufficient detail?*

This constraint holds especially for qualitative data (such as material from archives, interviews, or observations). While for instance issues of privacy 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 (on how to calibrate qualitative data for QCA, see Basurto & Speer, 2012; Tóth et al., 2017, and De Block & Vis, 2017 for a discussion).

- *When does being fully transparent turn into being non-transparent?*

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 the (online) appendix.

4. Practices and models of transparency in QCA

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

4a. 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). We assume that there is also wide agreement in this community about point (i), but the latter is not yet a common current practice in QCA-studies. All the points listed contribute to the five benefits mentioned above (interpretability, replication, clarity, refinement, and development).

QCA-studies should be transparent about:

(a) the "raw" data that are used,

(b) the way these "raw" data are calibrated into crisp, fuzzy, or multi-value sets,

(c) the resulting membership scores of cases in sets,

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

(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,
(f) the parameters of fit of the solution formula obtained,
(g) the cases covered by each solution term (so as to link the QCA results back to the cases), the cases that contradict each term, and the cases that remain unexplained by the entire solution formula,
(h) the robustness tests that have been conducted, and
(i) the 'script' used in the analysis, which should be provided so that other researchers can take the (raw) data and replicate all analytic steps that appear in the published article and the online appendix.

How should researchers present the information that is required for achieving transparency or openness? Much of the information can usually be integrated easily in an article-length piece. Points (a), (c), (f) and (g) in particular need to be reported in any study. The other points also need to be reported, but require some further elaboration. Information that cannot be presented in an article-length piece should be made available in online appendices, preferably in a machine-readable format in the case of standardized raw (or calibrated) data.

Regarding the *way the "raw" data are calibrated into crisp, fuzzy or multi value sets* (point b), the crucial information to be provided 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.

With respect to the *truth table and its logical minimization* (points d and e), there are three decisions researchers should be transparent about: (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 true logically contradictory cases (Schneider & Wagemann, 2012: 127). 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 (Schneider & Rohlfing (2013) use the terminology of deviant cases consistency in kind vs. in degree). 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 as-

sess 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.

Decision (2) relating to the truth table and its logical minimization that researchers need to be transparent about is their 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. This practice improves the replicability of the research.

Decision (3) relating to the truth table and its logical minimization that researchers should be clear about is how they have 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 assumptions on remainders), most parsimonious (all simplifying assumptions), and intermediate solution (only "easy" counterfactuals) (Baumgartner & Thiem, 2017; Ragin, 2008: 147ff; Schneider & Wagemann, 2012: 167ff). 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 [(Ragin, 2008: 147ff)], unwarranted, or even untenable assumptions [(Schneider & Wagemann, 2012: 198)]. Untenable assumptions run counter to common sense or logically contradict each other' (Wagemann & Schneider, 2015: 40). Along the same lines, researchers should also report explicitly the so-called directional expectations or arguments behind the assumptions made. Wagemann & Schneider (2015: 40) 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.' 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.

The importance of *reporting the robustness tests that have been conducted* (point h) 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 (see e.g., Baumgartner & Thiem, 2017; Thiem, Spöhel, & Duşa, 2016; Wagemann & Schneider, 2015). In general, we agree with Wagemann & Schneider (2015: 41) that the crucial point of robustness tests is 'to demonstrate that equally plausible analytic decisions would not lead to substantively different results.' Whether the appropriate robustness tests have been conducted is a matter for debate, and cannot be codified in transparency guidelines. We mean only to make the point 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' (Wagemann & Schneider, 2015: 41, see also Baumgartner & Thiem, 2017). 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 (see e.g., Baumgartner & Thiem, 2015; De Block & Vis, 2017; Marx, 2010; Skaaning, 2011; Thiem et al., 2016). Researchers should report in at least a footnote but preferably in an (online) appendix what are 'the effects, if any, of different analytic choices on the results obtained' (Wagemann & Schneider, 2015: 41). 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.

Finally, the precise format in which researchers can fulfil the transparency requirement of *providing a 'script'* (point i) of all the analyses performed depends on the software used for the analyses. In case researchers use script-based software, such as R, this transparency requirement is relatively straightforward. In addition to all command lines, the script should contain comments on these analyses performed and information on the packages (and their specific versions) used. In case researchers instead use graphical user interface (GUI) software, such as fsQCA, the 'script' could consist of a series of screen shots and verbal description of the steps taken. The latter is something that, to date, researchers rarely include (see Section 4b).

4b. What are low-cost improvements or innovations of transparency in QCA?

There are also some issues about which it is less common to be transparent, but which do warrant transparency.

- Scripts (list of commands for R [these are already usually provided when R is used; however, most QCA-researchers still use GUI software instead], screenshots for fsQCA or any other point-and-click software) should be provided. Providing this material is needed to allow for easy replicability of a study.
- Reporting 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.[4]
- Reporting model ambiguity. For one and the same truth table, there can be multiple logically equivalent solution formulas. Even though these formulas are *logically* 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 (2015: 41) 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.' Examples of studies reporting model ambiguities are Krook (2010) and Osa & Corduneanu-Huci (2003).
- 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 supersets of that outcome that pass the researcher's test criteria (consistency, relevance) should be reported and arguments be provided as to why those other supersets are not interpreted as necessary conditions (on necessary conditions in QCA, see e.g., Bol & Luppi, 2013; Rohlfing & Schneider, 2013, Goertz 2003).

---

[4] 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).

Issues at the border between QCA-as-an-approach and QCA-as-a-technique

Under this heading also falls an issue that is at the border between QCA-as-an-approach and the QCA-as-a-technique – namely the "going back and forth between theory and evidence" (Ragin, 1987, 2000). As Wagemann & Schneider (2015: 39) 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'. 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' (Wagemann & Schneider, 2015: 39). It does not add to transparency, though, 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, it undermines it (see Section 3).

4c. What are practices for cautious assessment or selective use regarding transparency in QCA?

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 report(s).

4d. 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. For instance, QCA researchers should not provide a "diary account" (Wagemann & Schneider, 2015) of the research process, burying important information (data calibration, qualitative anchors, parameters of fit, et cetera) in an overly lengthy journalistic-like description. Nor should they present the research as a hypothesis-testing exercise more suitable for mainstream statistical analysis, accordingly turning the QCA research process on its head.

In a similar vein, while researchers should report different solution formulas (conservative, intermediate, most parsimonious), only one should be used for substantive interpretation, not all of them.

Findings should, of course, be verbally presented and discussed, but this is not enough. Those findings need to be expressed in Boolean notation, with parameters of fit, and should include the cases (not) explained by the solution formula.

5. Discussion

All of the above listed points (a to i) seem uncontested and thus qualify as best "practices" – in this case regarding transparency in QCA – in the sense of '(…) transitory condensations of a shared understanding that are valid until improved' (Wagemann & Schneider, 2015: 38). 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.

And about which is there (still) substantial disagreement?

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.[5] In terms of transparency or openness, there is little to no substantial disagreement in the QCA-community.

References

Basurto, X., & Speer, J. (2012). Structuring the Calibration of Qualitative Data as Sets for Qualitative Comparative Analysis (QCA). *Field Methods*, *24*(2), 155–174.

Baumgartner, M. (2009). Inferring Causal Complexity. *Sociological Methods and Research*, *38*(1), 71–101.

Baumgartner, M., & Thiem, A. (2015). Model Ambiguities in Configurational Comparative Research. *Sociological Methods & Research*. http://doi.org/10.1177/0049124115610351

Baumgartner, M., & Thiem, A. (2017). Often Trusted But Never (Properly) Tested: Evaluating Qualitative Comparative Analysis. *Sociological Methods & Research*. http://doi.org/10.1177/0049124117701487

Bol, D., & Luppi, F. (2013). Confronting Theories Based on Necessary Relations: Making the Best of QCA Possibilities. *Political Research Quarterly*, *66*(1), 205–210.

Büthe, T., & Jacobs, A. M. (2015). Introduction to the Symposium: Transparency in Qualitative

[5] 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.

and Multi-Method Research. *Qualitative & Multi-Method Research*, (Spring), 2–8.

De Block, D., & Vis, B. (2017). Addressing the Challenges in Using Qualitative Data in Qualitative Comparative Analysis. *COMPASSS Working Paper*, (2017–88). Retrieved from http://www.compasss.org/wpseries/deBlockVis2017.pdf

Fiss, P. C., Marx, A., & Rihoux, B. (2014). Comment: Getting QCA Right. *Sociological Methodology*, *44*(1), 95–100.

Hall, P. A. (2016). Transparency, Research Integrity and Multiple Methods. *APSA-CP: Comparative Politics Newsletter*, 32–36.

Krook, M. L. (2010). Women's Representation in Parliament: A Qualitative Comparative Analysis. *Political Studies*, *58*(5), 886–908.

Lucas, S. R., & Szatrowski, A. (2014). Qualitative Comparative Analysis in Critical Perspective. *Sociological Methodology*, *44*(1), 1–79.

Marx, A. (2010). Crisp-set Qualitative Comparative Analysis (csQCA) and Model Specification: Benchmarks for Future csQCA Applications. *International Journal of Multiple Research Approaches*, *4*(2), 138–158.

Osa, M., & Corduneanu-Huci, C. (2003). Running Uphill: Political Opportunity in Non-Democracies. *Comparative Sociology*, *2*(4), 605–629.

Paine, J. (2016). Set-Theoretic Comparative Methods: Less Distinctive Than Claimed. *Comparative Political Studies*, *49*(6), 703–741.

Ragin, C. C. (1987). *The Comparative Method. Moving beyond Qualitative and Quantative Strategies*. Berkeley: University of California Press.

Ragin, C. C. (2000). *Fuzzy-Set Social Science*. Chicago and London: The University of Chicago Press.

Ragin, C. C. (2008a). *Redesigning Social Inquiry: Fuzzy Sets and Beyond*. Chicago and London: University of Chicago Press.

Ragin, C. C. (2008b). *User's Guide to Fuzzy-Set/Qualitative Comparative Analysis*. Tucson, Arizona: Department of Sociology, University of Arizona.

Ragin, C. C. (2014). Lucas and Szatrowski in Critical Perspective. *Sociological Methodology*, *44*(1), 80–94.

Rihoux, B., Álamos-Concha, P., Bol, D., Marx, A., & Rezsöhazy, I. (2013). From Niche to Mainstream Method? A Comprehensive Mapping of QCA Applications in Journal Articles from 1984 to 2011. *Political Research Quarterly*, *66*(1), 175–184.

Rihoux, B., & Ragin, C. C. eds. (2009). *Configurational Comparative Methods: Qualitative Comparative Analysis (QCA) and Related Techniques*. Los Angeles etc.: Sage.

Rohlfing, I., & Schneider, C. Q. (2013). Improving Research on Necessary Conditions: Formalized Case Selection for Process Tracing after QCA. *Political Research Quarterly*, *66*(1), 220–235.

Schneider, C. Q., & Rohlfing, I. (2013). Set-Theoretic Methods and Process Tracing in Multi-Method Research: Principles of Case Selection after QCA. *Sociological Methods and Research*, *42*(4), 559–597.

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

Skaaning, S. E. (2011). Assessing the Robustness of Crisp-Set and Fuzzy-Set QCA Results. *Sociological Methods & Research*, *40*(2), 391–408.

Thiem, A. (2014). Membership Function Sensitivity of Descriptive Statistics in Fuzzy-set Relations. *International Journal of Social Research Methodology*, *17*(6), 625–642.

Thiem, A., & Baumgartner, M. (2016). Back to Square One: A Reply to Munck, Paine, and Schneider. *Comparative Political Studies*, *49*(6), 801–806.

Thiem, A., Spöhel, R., & Duşa, A. (2016). Enhancing Sensitivity Diagnostics for Qualitative Comparative Analysis: A Combinatorial Approach. *Political Analysis*, *24*(1), 104–120.

Tóth, Z., Henneberg, S. C., & Naudé, P. (2017). Addressing the "Qualitative" in fuzzy set Qualitative Comparative Analysis: The Generic Membership Evaluation Template. *Industrial Marketing Management*, *63*(May), 192–204.

Wagemann, C., & Schneider, C. Q. (2010). Qualitative Comparative Analysis (QCA) and Fuzzy-Sets: Agenda for a Research Approach and a Data Analysis Technique. *Comparative Sociology*, *9*(3), 376–396.

Wagemann, C., & Schneider, C. Q. (2015). Transparency Standards in Qualitative Comparative Analysis. *Qualitative & Multi-Method Research*, *13*(1), 38–42.