STANDARDS OF GOOD PRACTICE IN QUALITATIVE COMPARATIVE ANALYSIS (QCA) AND FUZZY-SETS

Claudius Wagemann
Istituto italiano di scienze umane
Palazzo Strozzi, Piazza dei Strozzi
I-50123 Florence, Italy
Tel.: 0039 055 2673-308
claudius.wagemann@sumitalia.it
&
Carsten Q. Schneider
Department of Political and Social Sciences, Central European University
Nador utca 9, 1051 Budapest, Hungary
Tel.: 0036 1 327 3086
schneiderc@ceu.hu
http://www.personal.ceu.hu/departs/personal/Carsten_Schneider/

Comments most welcome!

A German version of this article appears as:
Schneider, Carsten Q.//Wagemann, Claudius (forthcoming): Standards guter Praxis in Qualitative Comparative Analysis (QCA) und Fuzzy-Sets, Pickel, Susanne//Pickel, Gert//Lauth, Hans-Joachim//Jahn, Detlef (eds.): Neue vergleichende sozialwissenschaftliche Methoden, Wiesbaden, VS-Verlag

1 *QCA AND THE SOCIAL SCIENCES*

Over the last couple of years, we witness an increasing curiosity for a methodological family, generally identified with its acronym, 'QCA'. This stands for 'Qualitative Comparative Analysis', which was introduced for the first time to a wider public by the American social scientist Charles Ragin in 1987 (1987). Since then, QCA has been modified, extended and improved several times (Ragin 2000; Ragin 2003b; Ragin 2006a Ragin 2006b; and Ragin and Sonnett 2004). These developments have contributed to a better applicability of QCA to empirical social scientific research questions and to its prominence within the discipline.

In this article, we will, first, present the 'state of the art' of QCA and will introduce both its basic principles and the different variants of this group of 'Configurational Comparative Methods' (a term coined by Rihoux and Ragin 2007a, which might probably substitute ‘Qualitative Comparative Analysis’ in the long run). After this, we will propose a list of criteria for a 'good' QCA analysis. We hope that our contribution can be a guideline for QCA users as to which aspects have to be considered when carrying out QCA analyses in order to render them not only technically correct, but also to make the best out of the analytically relevant information one can generate with QCA. Furthermore, the standard of good practice which we propose can also be a helpful instrument for readers and commentators when they have to evaluate empirical analyses based on QCA techniques.

2 *QCA AS A RESEARCH APPROACH AND AS A DATA ANALYSIS TECHNIQUE*

QCA has to be understood both as a research approach in a broad sense and as an analytical technique in a more narrow sense.

Briefly said, the interpretation of *QCA as a research approach* refers to the iterative process of data collection, model specification, case selection and re-conceptualization of the conditions and the outcome which are of central importance for any QCA-based research design. This aspect of QCA stems from its 'qualitative roots', since it is a common strategy in traditional qualitative comparative research to exclude and/or add cases from the analysis during an ongoing research process; to re-code values for certain cases; or to re-conceptualize entire variables. In contrast, most of these operations are usually strictly forbidden in quantitative, statistically oriented research.

The other aspect of QCA is that of *QCA as an analytical technique*. This refers to the so-called 'analytical moment', which sets in when the cases have already been specified and all conditions and the outcome have already been measured. At this stage of the QCA-based research process, the main goal consists in finding empirical patterns in the data, usually with the help of a computer. This aspect of QCA is very similar to quantitative, variable-oriented techniques of data analysis, such as, for example, regression analysis in its various forms. Unfortunately, these affinities between the two techniques have the undesired effect that quite a considerable number of QCA applicants and consumers tend to reduce QCA to this analytical moment and to overlook the broader view on QCA as a research approach.

Our article is based on the claim that QCA is not only a technique for data analysis, but also a research approach in a broader sense. This generates high standards for the research design and the following technical (computer-based and mathematical) data analysis in QCA. Whenever suitable, in the following we will refer back to the distinction between QCA as a research approach and QCA as an analytical technique.

2.1 Basic Principles of QCA

The general goal of a QCA analysis is to support the researcher in his/her attempt to arrive at a meaningful interpretation of the patterns displayed by the cases under examination.

The main principle dominating the *technical* aspect of QCA is the examination of set-theoretic relationships between causally relevant conditions and a clearly specified outcome. These set-theoretic relationships are then interpreted in terms of necessity and/or sufficiency. More precisely, if also theoretical arguments at hand, then a condition can be interpreted as sufficient, if always when the condition is present, the outcome is also present. Consequently, the sufficient condition is sub-set of the outcome. By contrast, a condition is necessary, if always when the outcome is present, the condition is also present. The necessary condition is a super-set of the outcome (Ragin 2000). Of course, such a way of thinking is not entirely new to the social sciences;[1] the same ideas were already the basis for Mill's methods (Mill 1865, Mahoney 2003b), which - as we know - have been widely applied in social science

[1] For more possibilities to define and formalize the concepts of necessary and sufficient conditions, see Goertz and Starr 2003.

research, even if not as directly applicable analytical techniques, then at least as logical systems on which comparative thinking is based. However, two problems frequently appear when we analyze empirical cases comparatively: first, very often, we do not find any conditions which are sufficient or necessary for *all* cases under examination. Instead, research reality will provide us with conditions which are sufficient and necessary only in combination with other conditions ('conjunctural causation') or which are only one alternative among others that only apply to some cases but not to others ('equifinal causation'). Mill's methods appear unsuitable for such complex causal relations. Furthermore, it is impossible to pursue the analytical combination of Mill's methods in a meaningful way beyond a certain number of cases and, therefore, a certain complexity of constellations of potential conditions.[2]

QCA takes this aspect of causal complexity into account by performing separate analyses for necessary and sufficient conditions in which conjunctural causal conditions are explicitly permitted and examined, and which allows for equifinal causal structures. This is achieved through a direct application of the rules of formal logic to the data which are conceptualized as set memberships (Schneider and Wagemann 2007 call this a 'Bottom-up procedure'), or with the help of a more sophisticated algebraic algorithm (Ragin 1987; for technical details, see the systematic presentation in Schneider and Wagemann 2007).[3]

Let us assume that we wanted to work out the sufficient (and necessary, see below) conditions for the stabilization of a democracy ('Y') and have - on the basis of the consultation of theoretical and empirical literature on this issue - identified a far developed economy ('A'), a homogeneous society without any notable social differences ('B'), and the dominance of a clan ('C') as causally relevant for the outcome.[4] The result of an analysis of the sufficient conditions could yield that

1 a simultaneous presence of a far developed economy and a homogeneous society without any notable differences is a sufficient condition for the stability of a democracy (= the simultaneous presence of both characteristics logically implies the outcome of a stable democracy); and that

[2] Even more, the standard application of Mill's methods ignores the pervasive and decisive problem of 'limited diversity' (see below and Schneider and Wagemann 2007: 109ff.).

[3] The computer software can be downloaded for free at www.fsqca.com (Ragin, Drass, and Davey 2006). TOSMANA is an alternative software with some additional modules, but with which the fuzzy set variant (see below) cannot be analyzed (Cronqvist 2006).

[4] Of course, all the examples put forward in this article just serve for the methodological illustration. We do not intend to contribute to substantial discussions.

2 as an alternative to this, the absence of a dominant clan is also a sufficient condition for the stability of a democracy (= wherever no dominant clan can be observed, we find a stable democracy).

We can conclude that two alternative possibilities (‚paths') for sufficient conditions exist which do not exclude one another. It is possible that both the first path (simultaneous presence of a far developed economy and a homogeneous society without any notable social differences) and the second path (absence of a dominant clan) can be observed for *one and the same case*. However, the interesting aspect of this solution term is that, in the case of the presence of a dominant clan (which means that the second path would not account for an explanation, since the sufficient condition of the dominant clan being *absent* is not fulfilled), the democracy can still be stable - namely, if both a far developed economy and a homogeneous society without any notable social differences can be observed.

Such a result is usually represented with a standardized formal notation. In our example, the result would be

$$AB + c \rightarrow Y. \quad (1)$$

'AB' stands for the combination of the conditions A and B.[5] The plus sign combines the two alternative paths to the outcome Y logically. It stands for the logical OR. This might be confusing at the beginning, since linear algebra, as we were taught at school, uses the plus sign for 'and'; it is interpreted as an 'or' in the algebras on which QCA techniques are based, namely, Boolean and fuzzy algebra (see below).[6] The small letter for the condition C indicates that not C itself, but its negation is a sufficient condition (not the presence of a dominant clan, but its absence) for the outcome. The arrow which points to Y means that the expression to its left-hand side logically implies the expression to its right-hand side (Ragin and Rihoux 2004); thus, it is a *sufficient* (and not a *necessary* condition), as long as this view is also backed by theoretical arguments.[7]

The analysis of necessary conditions proceeds in a similar way. As far as the example presented above is concerned, we can already guess from the solution for sufficient

[5] An alternative notation is A*B, where the * sign represents the logical AND or the intersection of the sets A and B, respectively.
[6] This is not an exclusive 'or' in the sense of an 'either…or', but the alternatives do not exclude each other. Ancient Latin differentiates better between these two 'ors', using 'aut' (exclusive or) or 'vel' (inclusive or).
[7] We are tempted to say that the combination AB + c 'leads to' Y. However, we recommend avoiding such a wording, since the arrow cannot be substituted with 'leads to' in the case of necessary conditions (see below).

conditions that no necessary conditions exist. If, however, a necessary condition X were to be found, then this could be expressed in the formal notation

$$X \leftarrow Y \qquad (2)$$

The inverse direction of the arrow does not suggest any causal mechanism. Y does not 'lead to' X. The arrow just represents a logical implication, that is, it says that, wherever we find Y, we will also find X.[8]

If we identify a *combination* of conditions as necessary for Y, then its interpretation is different from combined sufficient conditions (see our explanations above for AB). If the result of an analysis of necessary conditions were

$$XZ \leftarrow Y, \qquad (3)$$

then this certainly means that, on the one hand, the *simultaneous* presence of X and Z is a necessary condition for Y (*both* have to be present), but, on the other hand, this requirement of simultaneity in the case of necessary conditions also means that both conditions are *individually* necessary. They are necessary components of necessary conditions.[9]

As we can see, QCA helps us to work out how potentially sufficient and necessary conditions have to be combined with each other in order to account for an outcome. In this process, it can also happen that a factor, such as, e.g., A in the example

$$AB + c \rightarrow Y \qquad (4)$$

is neither alone sufficient nor alone necessary for Y,[10] but still plays a causal role. These conditions are called 'INUS conditions'. INUS stands for '*insufficient but necessary part of a condition which is itself unnecessary but sufficient for the result*' (Mackie 1974: 62; Goertz 2003: 68). The condition A is not sufficient, but it is a necessary component of the (combined) condition AB which itself is not necessary,[11] but only sufficient for Y. This means that - starting from a general focus on set-theoretic relationships - QCA enables us to model complex causal relations in such a way that also those factors are identified as causally relevant that are alone neither sufficient nor necessary.

Recently, some modules have been added to QCA which facilitate a less deterministic perspective (so-called 'consistency values', see Ragin 2006b, Goertz 2006, Schneider and

---

[8] As already mentioned above, the necessary condition represents – in set-theoretic terms – a super-set of the outcome Y, or, inversely, the outcome Y is a sub-set of the necessary condition X.

[9] Possibly, the QCA user also wants to consider a logical OR combination as a necessary condition (e.g., $A + B \leftarrow Y$). This is called a 'functionally equivalent condition' and is not without problems with regard to its substantive interpretation (Schneider and Wagemann 2007).

[10] As shown, no necessary conditions could be found in our example.

Wagemann 2007: 86ff.). Additionally, 'coverage measures' support the researcher in determining which percentage of the outcome is covered through a solution. We can differentiate between 'solution coverage' (indicating how much is covered by the solution term); 'raw coverage' (indicating which share of the outcome is explained by a certain alternative path); and 'unique coverage' (indicating which share of the outcome is *exclusively* explained by a certain alternative path) (Ragin 2006b; Schneider and Wagemann 2007: 90ff.).[12]

In line with the main goal of QCA - i.e. the meaningful interpretation of social relations in concretely specified cases - we can go beyond the purely analytical connection of causal condition with the outcome and also indicate which cases follow which sufficient path of the equifinal solution term. Applied to our example above: since every case shows a clearly determined set-theoretical membership in the two sufficient conditions AB and c, every case follows either both, one, or no path to the outcome.

2.2 Variants of QCA

As already mentioned, QCA can be understood both as a research approach and as a technique for data analysis. Above all the technical aspects of data analysis have undergone numerous modifications since their first publication (Ragin 1987). Today we can already speak of a 'QCA family'. The acronym QCA serves as a higher-order term encompassing all the variants which have been developed since the late 1980s. In order to avoid misunderstandings, Rihoux and Ragin (2007b) introduce the expression of 'Configurational Comparative Methods' (CCM).

The original version (Ragin 1987) is today referred to as 'Crisp Set QCA' (csQCA).[13] A 'crisp set' is a traditional set in which the single elements are either a member or not (Klir, Clair, and Yuan 1997: 48). For example, the element 'Sunday' is a member in the set of all days of the week, whereas the element 'January' is not a member of this set. With regard to conditions and outcomes, this means that csQCA requires phenomena (i.e., conditions and outcomes)

---

[11] If AB were necessary, then A alone would also be necessary.

[12] The consistency value might be conceptionally (though not mathematically) similar to the significance value of inferential statistics, and some of the coverage values might share some characteristics with measures which we know from regression analysis, such as the r^2 and partial correlation coefficients. However, in our view, such comparisons between the two methodologies just increase conceptual confusion instead of contributing to a better understanding of QCA (Schneider and Grofman 2006).

[13] Above all in older contributions, which had been written when csQCA was still the only variant of QCA, 'QCA' is often used as an acronym instead of the more precise csQCA. Of course, this may potentially lead to

either to be present or absent. Consequently, the researcher has to decide in every single case, if a democracy is present or absent; if a country is rich or not; if a revolution occurred in violent ways or not; if a system of interest intermediation is corporatist or not, etc. This binary structure of the data makes it possible to apply Boolean algebra in order to perform csQCA analyses (Klir, Clair, and Yuan 1997: 61). Of course, such a dichotomization is not without problems and has frequently been mentioned as a decisive shortcoming of csQCA (e.g. Goldthorpe 1997). The choice of the 'cut-off point' can have strong effects on the analytical result. Additionally, such a procedure does not correspond to the often highly differentiated (and anti-dichotomous) character of the social science data and theoretical reasoning. Clearly, the necessity to dichotomize the conditions and the outcome restricts the breadth of QCA's applicability and, also important, its acceptance in the academic community.

As a reaction to the shortcomings, limitations, and critiques on csQCA, 'fuzzy set QCA' (fsQCA, Ragin 2000) has been developed. Contrary to crisp sets, fuzzy sets are those sets in which an element is not limited to be a member or a non-member, but in which different degrees of membership exist. Consequently, fsQCA enables the researcher not only to decide if a democracy exists or not, but also to which degree it exists in a given case. More often than not, such gradation corresponds better to our social scientific thinking than the inherent necessity of csQCA to dichotomize concepts. Obviously, precision, discipline, and transparency of the codification rules – the so-called calibration of fuzzy sets - are indispensable (see our list below). We do not intend to concentrate on details of the calibration of fuzzy values (see for this Ragin 2000and forthcoming; Schneider and Wagemann 2007: 180ff.), but, at least, we would like to make the point that prior theoretical knowledge combined with empirical evidence is central in the calibration process (Ragin 2000: 150; see also Hall 2003: 389; Mahoney 2003b: 347). Thus, the data which are analyzed in fuzzy set analysis are also of qualitative nature, and they strongly depend on the research context. As a consequence, QCA (both csQCA and fsQCA) presents itself as a method based on qualitative-empirical social scientific principles and can be differentiated from standard statistical techniques (among others) for reasons of data generation and data quality (Ragin 2000, Kapitel 11, Schneider and Grofman 2006, Schneider and Wagemann 2007: 183f.).
From a mathematical perspective, fsQCA is no longer based on Boolean Algebra, but on fuzzy algebra (Klir, Clair, and Yuan 1997: 73ff.; Kosko 1993; Smithson and Verkuilen 2006,

---

considerable confusion.

Zadeh 1965 and 1968). This renders the technical processes somehow less intuitive and directly accessible than in the case of binary Boolean algebra. This might also have had the consequence that many researchers whose research question warrants the use of fsQCA (and not csQCA) are reluctant and unwilling to use the more complex algorithm of fsQCA (for technical details, see and Ragin 2006a and Ragin 2007 and Schneider and Wagemann 2007: 220ff.). Despite the fact that more fine-grained information about cases is contained in fuzzy sets, all concepts that are central to a csQCA analysis – necessity, sufficiency, equifinality, conjunctural causation, and even a truth table - can equally be applied to fsQCA analyses.

A further variant of configurational methods is presented by the so-called Multi Value QCA (mvQCA) approach (Cronqvist 2005). It allows researchers to work with multinomial concepts (e.g., different party families), that is, concepts that are not (implicitly) ordinal as is the case in fsQCA. However, this possibility to go beyond dichotomies only refers to the *conditions*, whereas the *outcome* in mvQCA still has to be dichotomous. A further problem of the application of mvQCA is that - even more than in csQCA and fsQCA - the problem of logical reminders emerges. Hence, in order to avoid that the problem of limited diversity[14] gets completely out of control, it is advisable to use only few multi-value conditions in mvQCA and these few conditions should only have three, maximum four different categories. (for more details see Schneider and Wagemann 2007: 262ff.).[15]

An interesting further argument in favor of QCA is that most verbally formulated social scientific theories (which represent the vast majority and exclude only ‘formal models’) can be interpreted as formulating set relations between the conditions and the outcome. Since set relations can be translated into relations in terms of necessity and sufficiency, we can find a surprising amount of theories which generate hypotheses regarding necessary and/or sufficient conditions (for an impressive collection of necessary conditions, see Goertz 2003). Not surprisingly, a method like QCA, which is based on formal logic and set-theoretic

[14] It is possible to create eight different conditions, using the dichotomous conditions A, B and C. These are ABC, ABc, AbC, Abc, aBC, aBc, abC, and abc. The general formula for the logical number of combinations is 2^k, with k being the number of the potential dichotomous conditions. If only seven cases are examined, using the three conditions A, B und C, or if eight (or more) cases are examined, which are in part equal with regard to their configuration of conditions, then some logically possible combinations remain without empirical cases. These ‘missing’ configurations are called ‘logical remainders; the set of logical remainders constitutes the phenomenon of ‘limited diversity’.

[15] Therefore, this text concentrates on csQCA and fsQCA.

concepts, is much more adequate than other data analysis techniques to approach these hypothesized set-relations.[16]

2.3 Epistemological Issues in QCA

The sub-title of Charles Ragin's first important publication on QCA (Ragin 1987), namely, '*Moving Beyond Qualitative and Quantitative Strategies*' already suggests that QCA can be perceived as an attempt to occupy a middle position in the debate between so-called qualitative and quantitative research strategies. In the 1990's this decade-old debate has again been revived, first in the American, but then also increasingly in the European social sciences (for contributions which can be regarded as 'classics', see King, Keohane, and Verba 1994 and Brady and Collier 2004). However, the term '*Qualitative Comparative Analysis*' also indicates that Ragin originally grouped QCA univocally with *qualitative* methods.[17] Although the discussion on the methodological evaluation of QCA often concentrates on this dichotomy of qualitative and quantitative methods, we will not join in, because, on the one hand, the terms 'qualitative' and 'quantitative' are too vague, and we, on the other hand, maintain other distinctions[18]as more important for the differentiation of research designs which correspond in part, but not completely to the common use of the terms 'qualitative' and 'quantitative'.

Neither do we intend to focus on the discussion about analytical techniques for small or large n (often also vested as the 'degrees-of-freedom problem') which is connected to the discussion on qualitative *versus* quantitative methods. Of course, the number of cases plays a role when categorizing QCA, but they are not as central as often assumed (Wagemann 2007). Rather, QCA is characterized – apart from by the process of the dialogue between theoretical ideas and empirical evidence (Ragin 2000) already discussed above and during which cases, variables and data can be re-specified – through its specific perspective on causality. We will discuss in the following which aspects of causality are especially emphasized in QCA, and how QCA is different from other, better known traditional approaches.

[16] This does not exclude that statistical instruments might also be helpful in examining necessary and/or sufficient conditions (see Dion 2003for possibilities offered through the Bayesian approach, and Braumoeller 2003and Braumoeller and Goertz 2003 for a discussion of other statistical approaches in this area).

[17] The French speaking tradition does not share this perspective and translates QCA with 'AQQC' ('*Analyse quali-quantitative comparée*') (De Meur and Rihoux 2002). Contrary to this, 'QCA' is usually not traduced in other European languages (such as German, Italian and Spanish); therefore, the acronym is also kept in these languages.

[18] Large N vs. small N; variable oriented vs. case oriented; standardized/formalized vs. non-standardized/non-

A first central element of QCA is the analysis of *necessary* and *sufficient conditions* and the set-theoretic perspective on causality. Regarding this point, QCA can be differentiated from the standard techniques of statistics which generally use correlations as proxies for causality and use probability statements for their generalization ('significance tests') beyond the sample to the underlying populations. But QCA is also different from single-case studies (as well as from historical studies) in that it claims to be generalizable to a given and clearly defined population (for the centrality of the concept of the 'population' in QCA, see Ragin 2000: chapter 2).[19]

The focus on necessity and sufficiency conceived as set relations is directly linked to the ability of QCA to work out *INUS conditions* which we have already mentioned above. Certainly, causal complexity also exists both in standardized statistical techniques and in (historical and non-historical) single-case studies, but it is much more restricted in these methods: in statistics, causal complexity often goes hand in hand with significant technical problems (e.g., the integration of interaction effects and the related loss of degrees of freedom, or the phenomenon of multicollinearity), whereas in comparative case studies causal complexity often leads to idiosyncratic explanations for every single case and is thus achieved on the expense of the generalizability of the results beyond the case(s) under examination.

Generally speaking, conditions do not exclude each other reciprocally or compete with each other in QCA (Ragin 2003a: 8, Ragin 2006a). Different components can - as already discussed above - be equivalent[20] alternatives for one another. This even goes so far that in a solution formula for sufficient conditions, such as

$$AB + aC \rightarrow Y \qquad (5)$$

a condition (in the example the condition A) takes on different roles: in order to produce Y it has to be *present* if combined with the condition B and *absent* if combined with the condition C.[21]

---

formalized, just to mention a few of the most common terms.

[19] A further difference between QCA – understood in the narrow sense of data analysis – and more traditional qualitative-comparative approaches lies in the treatment of the time dimension which is largely underdeveloped in QCA (see below).

[20] This logical equivalence of paths towards the outcome does not rule out the possibility to assess their (different) degrees of empirical importance, something achieved via the the coverage measures (see above).

[21] This means that multicollinearity also exists in QCA, because of its focus on simultaneously appearing phenomena, but that it is not a problem in QCA (Scharpf 2000: 59). It is rather one of the epistemological prior assumptions of QCA: more-dimensional social phenomena generally appear in clusters; not all logically possible types always become empirically manifest; and those conditions appearing in clusters exert their causal

In this context, the *equifinal* view of causality in QCA becomes an important component for the evaluation of the family of QCA methods. Equifinality is in sharp contrast to the unifinal perspective of many statistical techniques, among them the usually applied additive and linear regression models. In a regression equation of the type

$$y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \ldots + \varepsilon \qquad (6)$$

only one way exists how the outcome is produced, namely, the one described in the additive regression equation. Contrary to this, a solution for sufficient conditions in QCA shows (as we have seen above) which different paths count as *alternatives* for an outcome. This is indicated through the logical OR (+).

But not only most of the quantitative procedures have an (implicit) bias towards a unifinal understanding of causal relationship. Many qualitative comparative approaches also seem to share this characteristic, above all, if they are connected with Mill's methods. As discussed above, the perception of causal inference, as it is typical for these methods, requires the researcher to assume that causal effects are unifinal and additive and not equifinal and conjunctural.

Finally, the concept of *asymmetric causality* (Lieberson 1985) is also of importance when evaluating the potential of QCA for social science research. Many social science phenomena are the result of asymmetric causal processes and conditions. This means that the explanation of the presence of a phenomenon - say, the existence of a welfare state - does not imply that this explanation automatically also accounts for the absence of the same phenomenon, i.e. the non-existence of a welfare state. QCA is ready for such a thinking. Different to most of statistical procedures, which are based on correlation measures and which assume a symmetric relation between the correlated variables, QCA links conditions and the outcome through set-theoretical relations. And these set relations are asymmetric. Therefore, it is required in QCA to examine the presence of a phenomenon and its absence in two different analyses. Sometimes, the results can be surprising and can lead to a better understanding of the phenomenon under examination.

Thus, there are numerous reasons to claim that QCA supports the researchers more than other methodological proposals in accounting for the complexity[22] of the social world (and, above

impact on the outcome only in conjunction.

[22] Of course, there are other dimensions of causal complexity than equifinality, multifinality, conjunctural causality, and asymmetric causality. This refers above all to the time dimension: it is often of decisive

all, for the complex causal relations). This does not mean that other procedures have a lower value. QCA just extends the methodological repertoire insofar as it adheres to a very specific perspective of causality. Causality in QCA can be described as complex, equifinal, asymmetric and conjunctural, and is based on set-theoretic relationships, making use of the concepts of necessary and sufficient conditions. QCA is better equipped than other methods to model this kind of causality - but not an otherwise defined kind of causality.[23]

2.4 The Current QCA Agenda

Due to its young age, QCA is still under development and improvement, and the possibilities for its application are constantly improved through the launch of new software modules or even entire packages and innovative forms of graphical representation. Since methodo*logy* is also a scientific discipline itself, it is easily understandable (if not advisable), that social scientific approaches and techniques have to undergo a continuous review in order to improve them and to extend their functionality, their validity, and their applicability (for this aspect of methodology, see also Mahoney 2003a: 133). This is not different for more diffused techniques, such as, e.g., standard statistical approaches. Factor analysis, time series analysis and multi level analysis have only been diffused after the invention of powerful computers. Further examples are advanced graphical statistical techniques which have become increasingly prominent recently.

As far as QCA methodology is concerned, various improvements have been achieved. An important point is a stronger emphasis on *necessary* conditions which, above all in fsQCA, had been disregarded for a long time, compared to their sufficient condition 'brethren'. By now, clear indications for the analysis of necessary conditions exist which have also been implemented into the menu of the computer software fsQCA 2.0 (Ragin, Drass, and Davey 2006). A lot of the impetus of this increased focus on necessary condition should be

---

importance for the presence or absence of the outcome when exactly and/or in which sequence certain factors appear. Even if QCA still focuses on these central questions of qualitative research because of its close contact with the cases under examination, the formal integration of time, timing, and sequencing into the QCA algorithm only makes slow progress (Caren and Panofsky 2005, for a critique on this, see Ragin and Strand 2007).

[23] Therefore, the attempt to confront the analytical results, applying QCA and standard statistical analysis to the same data, is only of limited use. The two methodological strands are based on different epistemological assumptions which do not seem to make a comparison (or even a competition for the 'truth') suitable. (Even more, the available data is not always equally suitable for both modes of analysis.) Therefore, we are rather in favor of a triangulation of different techniques than of competing analyses. Thus, QCA neither replaces statistical analyses nor case studies, but complements the two approaches.

accredited to Gary Goertz' writings (e.g. Goertz and Starr 2003b). For different reasons before the publication of this anthology, the analysis of necessary conditions had been considered of secondary importance within the community of QCA applicants: first, every csQCA analysis always produces sufficient conditions,[24] but not automatically also always any necessary conditions. Second, already the daily usage of language invites the researcher to formulate sufficient conditions as the only explanation for a given outcome ('X *leads to* Y'). And, third, less skilled applicants of QCA often assume wrongly that a solution for sufficient conditions, such as

$$AB + AC \rightarrow Y \quad (7)$$

and the factoring out of A in the form of

$$A(B + C) \rightarrow Y \quad (8)$$

would automatically imply that A is a necessary condition for Y. However, such an interpretation of A and its factoring out from a logical OR statement is only permitted if all theoretically possible combinations of conditions are indeed represented by empirical cases, and if, additionally, no contradictory rows can be found in the truth table – an empirical situation that is rather rare in comparative social sciences. All this contributes to the wrong judgment that necessary conditions are just an automatic by-product of the analysis of sufficient conditions (for a more detailed discussion, see Schneider and Wagemann 2007: 63, 112ff.).

Whereas the goal of integrating necessary conditions into QCA has been satisfactorily achieved, Charles Ragin affronted another important topic which had also always been criticized. This concerns the question how fuzzy values are attributed to individual cases. Ragin introduced the expression of the 'calibration of fuzzy sets' for this step of the research process (Ragin 2000 and forthcoming). Certainly, no definite solution can be expected for this (e.g., a kind of recipe), but an equivalent to measurement theory in quantitative methodology is definitely needed. However, as already mentioned above, the process of generating data for a QCA analysis is an important characteristic of this approach, and a careful design of the data matrix is central for the success of every QCA analysis.

[24] The reason for this lies in the algorithm of csQCA which we do not intend to discuss in more detail here. Briefly stated, any truth table row which shows the outcome is already a (raw) sufficient condition for the outcome. Therefore, the analysis of sufficient conditions *always* leads to a result, if at least one truth table row is connected to the outcome to be explained.

Yet another problem which, ultimately, cannot be 'solved' is the issue of how to treat logical remainders. This refers to that situation that not all theoretically possible combinations are represented through empirical cases. However, some progress has also been made in this field which go beyond the original variants of the 'most parsimonious solution', 'blanket assumptions' and 'thought experiments' (Schneider and Wagemann 2007: 101ff.). The new proposals include the integration of 'simple counterfactual assumptions' (Ragin and Sonnett 2004); the avoidance of contradictory simplifying assumptions (Vanderborght and Yamasaki 2003); or the analytical organization of causal processes in two (or more) combined QCA steps (Schneider and Wagemann 2006).[25] All these approaches refer to QCA as a data analysis technique. However, one of the most important contributions to the current methodological discussion is to have created - if not a solution - at least awareness for the central importance of the phenomenon of 'Limited Diversity' in social sciences based on observational data.

Further recent developments concentrate on improvements regarding the presentation of QCA. This includes both developments in the area of software packages[26] and those contributions which concentrate on the notation and the graphical representation of QCA (Schneider and Grofman 2006). Indeed, it is not sufficient to present the results of QCA just in form of a solution formula. Since QCA is conceptualized as a method at the interface between qualitative case-oriented and quantitative variable-oriented research, presentation and interpretation have to reflect both the case and the variable perspective. For this, different instruments, such as truth tables, Venn diagrams, X-Y plots and dendograms exist (Schneider and Grofman 2006).

Insofar, we can conclude that the QCA tool set is increasing. This also means that the group of applicants becomes always larger. Unfortunately, though, the diffusion of an analytical technique does not automatically mean that the application standards also diffuse to the same extent. Whereas standardized statistical techniques are based on clear requirements how to apply single procedures correctly, and which issues to consider when presenting the result, such a 'Code of Good Conduct' is largely missing for QCA. This is not a small omission since

[25] In this approach, the level of causality is further differentiated by distinguishing between ‘remote’ and ‘proximate’ causal factors. Thus, two-step approaches do not only contribute to a solution of the problem of limited diversity, but also account for a better integration of formal solution and theoretical hypotheses, since it reflects the different levels of causal effects which are typical for most social science theories.

[26] Most prominently, TOSMANA has become a fruitful addition for csQCA analysis and is the only software to cope with mvQCA problems, see Cronqvist 2006). In addition, there exists a QCA package in R software (Dusa

such a list of desired QCA practices would not only enable the applicants to be more confident about the reliability and validity of their results, but it would also help the scientific community to have easier access to QCA results. Univocal standards facilitate the communication, even if recipients only have basic knowledge about a method. As we all would agree, even those social scientists who have never carried out a linear regression by themselves, should know the meaning of an r^2, and which elements have to be included when presenting the results of a regression analysis.

Within the QCA community, this necessity for a standard of good practice has been recognized, but has been approached in only a rudimentary manner (see the remarks in Ragin and Rihoux 2004: 6ff. and Yamasaki 2003: 3). In the following, we start from these ideas, but extend them considerably. Of course, this is 'work in progress' in the best sense - our list is a proposal for discussion which can and must obviously be further extended or even changed.[27]

3 A GOOD QCA ANALYSIS FROM A TO Z[28]

We will divide our list of good QCA practice in six categories in order to emphasize the argument that QCA is not just another (computer-based) data analysis technique, but that QCA also has to be understood and applied as a research approach in the broad sense. *Before* coming to the ‘analytic moment’ of data analysis, it is indispensable to focus on case characteristics. *After* the analysis, the plausibility of the results must be assessed by linking back the results to the cases. Sometimes, the data analysis must even be repeated with a modified set of cases and/or the conditions. The following list of guidelines is structured along these broad lines.

3.1 Criteria Concerning the Purpose of QCA

a) *QCA as a data analysis technique should be used for its original aims.*

2007).

[27] The single points of the list are taken from the textbook of the two authors of this article (Schneider and Wagemann 2007: 266ff.), where they serve – in difference to this article – only as a general conclusion, without any further explanations.

[28] Thanks go to Simone Ledermann and Raphaela Schlicht for their help in translating this part of the article from German into English.

Ragin and Rihoux (2004: 6) mention five aims of QCA: first, data representation in the form of a truth table; second, a check of the consistency of the data; third, a test of existing hypothesis or theories;[29] forth, a quick overview of the basic assumptions of the analysis; and fifth, the development of causal hypotheses on the basis of observable patterns in the data. Of course, it is also possible to pursue more than one purpose of QCA in the framework of a research project, if needed.

b) *QCA should not be applied as the only data analysis technique in a research project.*

Note that other research designs and data analysis techniques also have important application areas. Indeed, the different methods should be used in a complementary way in order to achieve triangulation. This is all the more essential if the aim is to make causal inferences. QCA is particularly useful for a combination with conventional (comparative) case studies. On the one hand, case studies account for the familiarity with the cases that is indispensable for a QCA-based data analysis. On the other hand, the results produced by QCA provide detailed information about which (combinations of) factors were sufficient for the outcome in a certain group of cases. Due to its focus on complex causal structures, which distinguishes QCA from statistical techniques, it offers more precise insights about which further steps could be undertaken in subsequent (comparative) case studies.

Restriction: Possibilities of triangulation are often limited by the requirement to present research results on less than 20 pages. In the case that QCA is the only analytical technique used, as it might often happen for journal articles, it is still important to describe the research process that generated the data and to mention which other methods (case studies, statistical analyses, etc.) are planned to be added to the QCA results.

3.2 Criteria Concerning the Research Strategy

c) *QCA should never be applied in a mechanical way; instead, it should always be related to the cases.*

Due to the fact that the software is relatively easy to handle, there is a temptation for users to feed the computer with data and to just to see which results can be produced. This bad habit, also well known from superficial statistical applications, is even worse in the case of QCA,

[29] We would like to add that the hypotheses should consist of statements about sufficient and/or necessary conditions and should not be phrased in the more common language of covariations.

because one of its principal epistemological aspects consists in capturing the characteristics of cases accurately. If the cases disappear behind a computer-based algorithm and behind coefficients of consistency and coverage, the method looses one of its major strengths.

Restriction: The explorative element of approaching the data is stronger in QCA than in statistical techniques. Ragin calls this the 'dialogue between (theoretical) ideas and (empirical) evidence'. As a consequence of the explorative character of QCA results, they are always provisional, as they should always be followed by additional case studies and statistical or QCA analyses.

d) *Familiarity with the cases is a requirement before, during and after the analytical moment of a QCA analysis.*

Researchers should try to acquire as much knowledge as possible about their cases at all stages of the process. *Before* the analysis, familiarity with the cases makes it easier to identify analytically relevant conditions and to specify each case's membership in them; *during* the analysis, it is useful for the selection of parameters (such as the consistency values); and *after* the analysis, it facilitates the interpretation of the results. Additional information from 'causal process observation', as Collier, Brady und Seawright (2004: 252ff.) called it, enhances the possibility to draw causal inferences, even though the number of variables or cases remains the same.

Restriction: QCA is increasingly used to analyze individual level data (e.g. Ragin 2006a), where familiarity with the single case is usually less central. Instead, it should be replaced by familiarity with *types* of cases as defined by equifinal QCA solutions. The different types of individuals can be described in more detail (also by statistical procedures like factor or cluster analysis) by including other analytically relevant characteristics not used in the QCA analysis.

3.3 Criteria Concerning the Representation of QCA

e) *Whenever possible, the raw data matrix should be published.*

We assent to the proposition by Yamasaki (Yamasaki 2003: 3, see also Schneider and Grofman 2006) to include the raw data, since a profound knowledge of the cases is central for any QCA analysis. Not only should the authors of QCA studies know their cases, but this knowledge should also be passed on in a clear and understandable way to the recipients. In addition, publishing the raw data allows the replication of a QCA analysis.

Restriction: Some data sets might be to big for a scientific publication. In this case, the original data should be published on the internet or easily made accessible on demand.

f) *The truth table should always be reported.*

The truth table is an aggregated form of the raw data when the set memberships of the cases have been assigned. Truth tables are the basis for all subsequent QCA analyses. In order to guarantee replicability, they should always be published (Schneider and Grofman 2006). Truth tables give an indication of analytically identical cases and of the phenomenon of limited diversity. Usually, truth tables are not very space consuming, so they can be easily placed in the appendix of a publication.

Restriction: If the truth table has many rows because there are many conditions, the representation of logical remainders (i.e., logically possible combinations of conditions for which no empirically observed cases are at hand) can be eliminated. In this case, however, the kind and extent of limited diversity should be described via a Boolean expression.

g) *Every QCA analysis must contain the solution formula(s).*

The solution of the analysis of necessary and sufficient conditions should not only be provided in a 'narrative' way, but also in a formal and correct notation. For sufficient conditions, an arrow → or a ≤ sign should be used,[30] whereas either the inverted arrow ← or a ≥ sign should be used for necessary conditions.

Restriction: Under certain (rather rare) empirical conditions, the = sign is appropriate. This is the case when the result of the analysis is based on a fully specified truth table, i.e., without contradictory rows, and when the logical remainders are substantially irrelevant; logically possible but substantially impossible; or when they can be assigned a clear outcome value (1 or 0) on the basis of 'easy counterfactual arguments' (see Ragin and Sonnett 2004).

h) T*he consistency and coverage measures should always be reported.*

This is a relatively new requirement, given that the formulas for consistency and coverage have been introduced only recently (Ragin 2003b; Ragin 2006b). The information they contain is important, because the measures of consistency and coverage do not only express

[30] The use of unequal signs is based on fsQCA notation (Ragin 2000) and stems from the fact that necessity and

how adequate the analysis was. In particular, coverage measures also assign weights to the different paths of an equifinal solution, which helps to improve the interpretations of the solution formula.

Restriction: The *empirical* significance of a path, measured by the degree of coverage of the outcome to be explained, is not equivalent to its *theoretical* significance. Some paths with a high coverage can be theoretically uninteresting or even trivial. Likewise, researchers should not focus on any minimum value of consistency and hide those cases that deviate from broad patterns.

i) *The appropriate QCA terminology should be followed.*

QCA has developed its own terminology. As QCA is based on the principles of formal logics and Boolean or fuzzy algebra, as opposed to linear algebra, the term 'conditions' and not 'independent variables' is used. Similarly, the phenomenon to be explained is called 'outcome', and the term 'dependent variable' is avoided. Using this vocabulary is formally more correct and diminishes the risk of confusing the underlying logic of QCA with the one of other data analysis techniques, such as regression analyses, that might look similar on the surface, but which are based on different mathematical procedures and epistemologies.

Restriction: In studies that use QCA and other (statistical) methods in parallel, terminological differences can sometimes lead to stylistic problems and substantive confusion.

j) A*s many forms of representing QCA results as needed should be used in order to depict both the case-oriented and the variable-oriented aspects of QCA.*

As we know, QCA aims at explaining single cases and, at the same time, at unraveling relationships between causally relevant conditions on the one hand and the outcome on the other. In addition, the degree, to which the analytical results reflect the underlying data structure, should also be reported (Schneider and Grofman 2006). In order to fulfill these three aims, researchers should resort to more than one form of representation. For example, the membership value of the cases should be indicated for each path of an equifinal solution. There are also graphical possibilities of representation: Venn diagrams, dendograms, XY-plots (in case of fsQCA) and others offer the possibility to highlight a certain aspect of the results (see Schneider and Grofman 2006for a detailed discussion of the different possibilities of representing QCA results).

---

sufficiency can be perceived of as subset relations between the condition and the outcome.

Restriction: Sometimes, it is impossible (and probably often not appropriate) to use all the graphical forms of representation in a single publication. The adequate forms of representation should be select on the basis of the characteristics of the research project (research question, number of cases, etc.).

3.4 Criteria for the Selection of Cases, Conditions, Set Memberships, and Truth Table Algorithm Criteria.

k) *There should always be an explicit and detailed justification for the* (non)*selection of cases.*

The literature in comparative methods provides a whole catalogue of criteria about how to select cases (King, Keohane, and Verba 1994: 124ff.; Collier, Mahoney, and Seawright 2004; Morlino 2005: 51ff.). Obviously, cases should not be selected because data for them is readily available or because they are best suited to 'prove' one's own hypotheses. The general rules of case selection also hold for QCA. An explicit case selection and definition of the population underlying the selected cases is all the more important, because causal inference in QCA is not based on notions derived from inferential statistics. As a consequence, results, first of all, hold for the cases that have actually been examined. One can only generalize to other cases on the basis of clearly specified *scope conditions* (Walker and Cohen 1985), which delimit the universe of cases for which the causal relation examined is claimed to hold.

Restriction: Of course, it will sometimes not be possible to generate data for some of the cases which were initially selected and which, therefore, have to be excluded from the analysis. Under these circumstances, the definition of the relevant population has to be reassessed and explicitly defined once again (Ragin and Becker 1992).

l) *The conditions and the outcome should be selected and conceptualized on the basis of adequate theoretical and empirical prior knowledge.*

The selection and definition of the conditions and the outcome has to be precise. However, sometimes the selection of conditions has to be adapted during the research process (this is also true for the case selection). Such a re-specification of the cases, the conditions, or even the values of cases in certain conditions stands in marked contrast to best practices in statistical research, where the data are said to be inviolable once they have been collected. In the qualitative research tradition, an understanding of the results and processes in the cases is much more important, so that going back and forth between a preliminary data analysis and adaptations of the data set is very common.

Restriction: The iterative process of data and case specification cannot be continued *ad infinitum.* At one point, the researcher has to decide whether the research project still corresponds to the original idea. If not, the results should be presented to the public and a new project be started.

m) *The number of conditions should be kept moderate.*

It is tempting to run an analysis of every possible condition in order to have an exhaustive view of sufficient and necessary conditions. However, just like in statistical analysis, where too many independent variables 'destroy' the results simply because coefficients will not be significant, a high number of conditions is also dysfunctional for QCA. On the one hand, the number of logical remainders (i.e., logically possible combinations of conditions for which no empirical cases exist) will grow considerably, leading to the above mentioned inferential problem of limited diversity. On the other hand, many conditions produce very complex results that can be hard to be interpreted on the basis of theory.[31]

Restriction: The number of conditions can be slightly higher for individual data. As a rule, these data are usually characterized by a higher level of heterogeneity than macro unit data, which, in tendency, reduces the number of logical remainders. At the same time, a higher number of conditions will help to reduce the number of contradictory rows (csQCA) and to produce more truth table rows with high consistency values (fsQCA truth table algorithm).

n) *The dichotomization (csQCA) or calibration (fsQCA) of membership values should be discussed in detail.*

Both the so-called qualitative anchors (0 and 1 in crisp set and 0, 0.5, 1 in fuzzy set) and the coding rules for assigning set memberships to cases must be transparent and explicit. These decisions need to be based on theoretical and empirical information, and not just on mathematical operations. Thus, purely automatic transformations of metric variables to the [0,1] interval should be avoided and substantial argumentation should take the lead, instead.

Restriction: Variable measurement always implies a reduction of theoretical concepts and, as such, often provokes criticism, even if it is explicitly discussed. In other words, concept formation and measurement of social reality, in general, and set membership calibration, in

[31] See Marx 2006for a methodological experiment on the acceptable proportion between the number of cases

particular, are interpretative acts, ideally following transparent rules and, thus, being subject to debates.

o) *In csQCA, contradictory truth table rows should be resolved before the minimization of the truth table algorithm*

Contradictory rows in csQCA mean that a specific configuration of conditions can lead to different outcomes (two cases are identical in their conditions but display different outcome values). The difference in the outcome, thus, cannot be explained by the conditions which are used. In order to resolve these contradictions, first, case specification should be improved, other variables should be added, and/or the outcome should be re-conceptualized, before any technical solution is applied, whereby any technical solution comes down to making imposing an outcome value to the contradictory row (in some instances by the computer algorithm) which is not in line with the empirical evidence for some cases.(see Ragin 1987: 113ff.; Schneider and Wagemann 2007: 116ff., and point 't' of this list). Notice that in fsQCA, the problem of contradictions is conceptualized by measures of consistency.

Restriction: Any of the possibilities to treat contradictory rows comes at a trade-off.

3.5 Criteria for the 'Analytic Moment's

p) *Use computer software to minimize the truth table.*

While it is possible, and sometimes even desirable, to minimize less complex truth tables by hand through the above mentioned principles of Boolean algebra – even if just to be confirmed that the computer comes to the same conclusion - it is a simple fact that computers, by definition, are less subject to human error than human beings are.[32] Therefore, truth tables should always be minimized with the appropriate computer software.

Restriction: If the truth table contains very few conditions and cases, a logical minimization is equally feasible by hand. Then, the researcher is more conscious of the underlying data minimizing procedure than (s)he would be if (s)he just pressed the relevant buttons using the software.

---

and the number of variables.

[32] See Caren and Panofsky 2005 as a good example how logical minimization can lead to less than minimal solution terms. However, Ragin and Strand 2007 demonstrate how Caren's and Panofski's solution term can be further minimized.

q) *Necessary and sufficient conditions should be analyzed in separate analytical steps.*
In this paper, we have repeatedly stressed the point that the analysis of necessary conditions represents a separate analytic step of its own. Only under very peculiar conditions, the analysis of sufficient conditions also reveals the necessary conditions – provided they are present in the data. The reason for this is that the logical minimization of a truth table on the above mentioned Quine-McCLusky algorithm is essentially an analysis of sufficient conditions. Hence, only if necessary conditions were explicitly targeted and analyzed, statements about necessity should be made. As a rule, the analysis should always start with the necessary conditions (Schneider and Wagemann 2007: 112ff.).
Restriction: If the truth table is fully specified, i.e., if no contradictory rows and no logical remainders exists, and if the truth table is *not* based on fuzzy data to which the fuzzy set truth table algorithm (see Ragin 2006a and forthcoming and Schneider and Wagemann 2007: 220ff.) has been applied, then the logical minimization of such a truth table also automatically yields necessary conditions – provided they are present in the data.

r) *The analysis of sufficient conditions should always be performed with and without simplifying assumptions regarding the logical remainders. Both solution formulas should be reported.*
As mentioned, logical remainders and thus limited diversity are omnipresent in comparative social research based on observational data. The different treatments of these logical remainders (Ragin 1987: 104ff.; Ragin and Sonnett 2004, Schneider and Wagemann 2007: 101ff.) lead to different solution formulas, but all formulas are logically true because they do not contradict the available empirical information contained in the truth table. The formulas differ in their degree of complexity, or better, precision. Our suggestion is to produce at least two solution formulas: one based on simplifying assumptions (performed by the computer) on the logical remainders, which will always lead to the most parsimonious solution, and another one without any such simplifying assumption, which will always lead to a more complex solution term.[33] The solution formulas of both procedures should be made public.
Restriction: When it comes to the theoretical and substantive interpretation of the results, the researcher is free to choose which formula(s) to put into the center of attention.

s) *The treatment of logical remainders should be transparent.*

[33] This conservative treatment of logical remainders leads to the most *complex* solution if the most *parsimonious*

When publishing results based on QCA, the researcher should make clear how (s)he dealt with the phenomenon of limited diversity. This requires, in a first step, to specify whether or not logical remainders exist in the truth table and, if so, what type(s) of logically possible ‘cases’ were not empirically observed. Such a specification (best to be done in the form of a Boolean expression) of the type of limited diversity on which the empirical study is based is a useful starting point for formulating the scope conditions under which the subsequent empirical results are claimed to be valid (Ragin 1987).

Furthermore, it must be explicitly justified which of the different strategies for dealing with logical remainders during the logical minimization process were applied. This information is indispensable for other researchers who want to reproduce the analysis. In this context, Ragin and Rihoux point out that it is helpful to list the simplifying assumptions that are generated by the computer when the option of the ‘most parsimonious’ solution term is specified in the computer software (Ragin and Rihoux 2004: 7 and Schneider 2006: Online Appendix VIII).

Restriction: Apart from the common space restrictions in scientific publications, there should be no other reason for not fully following this rule of good QCA practice.

t) *The treatment of contradictory rows (in csQCA) and of inconsistent truth table rows (in fsQCA) in the logical minimization process should be transparent.*

If all attempts to solve the problem of contradictory rows have failed and thus the truth table contains contradictory rows, then the rules for their treatment are similar to those for logical remainders just specified under ‘s’: the researcher needs to be explicit whether such rows exist in the truth table; how many of them there are; and how they were treated in the process of logical minimization. If the so-called truth table algorithm is used, explicit reasons must be provided which threshold value was chosen above which a given truth table row is considered to be a sufficient condition for the outcome (Ragin 2007 and Schneider 2006, Online Appendix V). Such arguments should be based on characteristics of the research, such as the number of cases, the researcher’s intimacy with the cases, the quality of the data, and the precision of existing theories. In addition, consistency values across all logically possible truth table rows often show a gap between very high and very low values; using this empirical gap for setting the threshold can often be an appropriate choice.

Restriction: For the time being, the truth table algorithm (Ragin 2007) has clear advantages in fsQCA and should be preferred over the old inclusion algorithm described in Ragin 2000. For

solution term is based on the assumption that all logical remainders would lead to the outcome to be explained.

csQCA, it can be argued that the Quine-McClusky algorithm is better suited when the number of cases is not very high and only few contradictory rows exist. However, when the number of contradictory rows increases, as, e.g., in the application of QCA to individual data, the application of the 'truth table algorithm' should even be preferred in csQCA.

u) *The outcome and the negation of the outcome should always be analyzed in two separate analyses.*

Even if the negation of an outcome is often not part of the hypotheses and theories to be examined, the analysis of the negation of the outcome is recommended, since the analysis of negative cases can either help to understand the causal logic driving the positive cases and/or can generate substantively interesting insights in their own right (see Ragin 2004: 130ff. on the general importance of negative cases for drawing inferences in social science research). The solution formula for the non-occurrence of the outcome can either be derived applying De Morgans law (Klir, Clair, and Yuan 1997: 37) or performing a separate analysis in which the negation of the outcome is specified as the 'dependent variable'.

Restriction: De Morgan's law can only be meaningfully applied if the truth table which had been minimized in order to generate the solution formula for the occurrence of the outcome was fully specified, that is, that there were no logical remainders and no contradictory rows (Schneider and Wagemann 2007: 112ff.). Since such a situation is rather the exception than the rule in empirical social science based on observational data, the default option should be to run a separate analysis for the negation of the outcome. After such an analysis, careful attention must be paid to the danger of having made contradictory simplifying assumptions (Vanderborght and Yamasaki 2003), that is, logical remainders for which the computer assumes the outcome value of 1 in one minimization procedure and the value of 0 in the other minimization process. Researchers must check and report whether such contradictory simplifying assumptions were made and, if possible, such assumptions should be avoided altogether (see Schneider and Wagemann 2007: 167ff. for an adequate procedure). Furthermore, researchers should spend some thoughts on whether or not a (slightly) different set of theories and thus conditions should be used when shifting from the analysis of the outcome to the analysis of the non-outcome.

3.6 Criteria for the Interpretation of Analytic Results

v) S*ingle conditions of a conjunctural and equifinal solution term should not be (over)interpreted.*

The exclusive interpretation of single conditions which only appear as causally relevant in conjunction with different combinations of other single conditions is not in line with the epistemological foundation of QCA. QCA rests on the assumption – and, in fact, almost exclusively produces results that show – that the *interplay* between single conditions explains the outcome, not single conditions in isolation. QCA is a configurational method, and this should also be reflected in the interpretation of the result.

Restriction: If in a given research field strong consensus prevails that a particular condition alone and in isolation from any other condition is indispensable for producing the outcome, then a researcher might want to pay tribute to this prominence in his/her interpretation of the QCA results. Often (obviously depending on the patterns in the empirical data), the researcher will be able to conclude that the alleged necessary condition does not show up as a necessary condition, once the methodologically induced assumptions about the simplicity of causal relations are made more flexible, and conditions are shown to imply the outcome only if they are combined in different ways. Often, the researcher will even be able to show that more than one conjunctural path exists towards the outcome, and that some of them do not include the prominent single condition.

w) *The researcher should always give explicit justifications in case one (or more) of the paths towards the outcome are deemed more important than others.*

One possibility to argue that one path is more important than another is the empirical measure of (unique and/or raw) coverage. However, empirical relevance is different from theoretical relevance. Sometimes an empirically less important path (a path covering only a few, probably even only one case) can be theoretically and substantively more interesting and important than another path covering many cases but about which everybody has already had sufficient knowledge. Hence, conjunctions that are theoretically unexpected and/or cover otherwise purely understood cases can often yield more insights than paths stating obvious insights.

Restriction: The complexity of the solution term (perceived of as the number of individual paths, their overlaps, and the number of single conditions involved in them) might make it difficult to give premium to one or two of these paths. In such a situation, the researcher should try and treat all paths towards the outcome as functional equivalent empirical manifestations of a concept that is situated at a higher level of generality (see Schneider and Wagemann 2006 for such a strategy).

x) *The solution formulas should be linked back to the cases.*

Researchers should make clear which cases – best be addressed by their proper names – are covered by which of the paths in the solution formula. This is the ultimate test of whether or not the results generated by the logical minimization make sense, and if they are useful for understanding the cases – the primary goal of QCA. If fsQCA is performed, X-Y-plots are particularly useful in displaying either the entire solution formula and/or different paths towards the outcome. X-Y-plots show straightforwardly where single cases fall on the fuzzy scales of the outcome and the (conjunctural) condition. In addition, they provide a series of additional information which is relevant for assessing the quality of the fsQCA results (Schneider and Grofman 2006, Schneider and Wagemann 2007: 197ff.). First, X-Y-plots show whether the specific condition is necessary (lower triangular plot) or sufficient (upper triangular plot). Second, they give an impression how consistent a given condition is with the statement of being a necessary or a sufficient condition, respectively. This means, they visualize the coefficient of consistency. Third, X-Y-plots offer graphical insights on how empirically relevant a sufficient condition is,[34] and whether or not a necessary condition might be empirically (and thus also often theoretically) trivial[35].

Restriction: This issue should be followed without any restrictions. As mentioned, QCA is more than just a data analysis technique, but also a research approach that primarily aims at understanding the cases. If QCA is applied to individual level data, the focus on cases should be replaced by focus on types of cases. Instead of referring to individual names (i.e., Michael, Tom, Anne, etc.) scholars should use analytically meaningful categories such as young males, etc., which distinguish the individuals following different paths (see also our point ‘d’).

y) *The coefficients of consistency and coverage are important components of the analysis and interpretation of QCA results.*

[34] For instance, it is substantial nonsense to claim that the presence of a dictator is a sufficient condition for economic growth in Western Europe in the 1990s, simply because there was not a single dictator in Western Europe during that time. In terms of formal logic, the absence of dictators qualifies as a sufficient condition for economic growth in Western Europe of the 1990s, though.

[35] A trivially necessary condition would be, for instance, air to breath for the occurrence of war. The issue here is that, while, logically speaking, this statement is true, it is substantively trivial because air to breath is literally everywhere – no matter whether in cases of war or non-war. In other words, it comes close to being a constant.

We have already addressed these coefficients under ‘h’. We abstain from mentioning concrete values of consistency and coverage which should be deemed as ‘good’ or ‘acceptable’ across all QCA applications. In macro-analytical QCA-applications based on a medium-sized N (30-60), the authors of this paper have made good experiences with consistency values of 0.7 and higher for sufficient conditions. For necessary conditions, consistency should be set higher (see Schneider and Wagemann 2007: 213 for a thorough discussion of this point).

Restriction: In general, the thresholds for consistency and coverage vary with the research design (number and knowledge of cases, quality of data, specificity of theories and hypotheses, and aim of research). Unlike in broad areas of statistical research, where certain levels of significance have reached a doctrine-like status, QCA researchers should resist as much as possible to follow conventions simply for the sake of being conventions and should, instead, explicitly argue for their decisions made on the level of consistency.

z) *The solution formula alone does not demonstrate a causal relationship between the conditions and the outcome.*

Similar to any other data analysis technique in the social sciences, the task for the QCA researcher consists in spelling out the causal link (or causal mechanism) between the condition and the outcome in a narrative fashion. Thus, QCA, like any other data analysis technique, needs theory to bridge empirical results with analytic interpretation. When performing this task, detailed discussions of cases often are very useful. In particular, such in-depth analyses of a few cases bring the analytic relevance of the time-dimension in understanding social phenomena to the fore, a dimension, which, so far, can only be dealt with in indirect ways in QCA (see Caren and Panofsky 2005 and Ragin and Strand 2007).

SUMMARY

In this contribution, we have first presented the logic and the epistemological foundation of QCA. Doing so, we have differentiated between two essential aspects of QCA: one the one hand, QCA as a systematic, case-oriented approach and, on the other hand, QCA as a data analysis technique. We have clarified that QCA can fully unfold its potentials only in a skilful dialogue and combination of these two phases of a research process. Above all, we have underlined the notion of causal complexity that plays a central role in QCA. Causal complexity refers to the concepts of equifinal, conjunctural, and asymmetric causality, concepts, which in turn can be adequately expressed with the terms of necessary and sufficient conditions.

We have then detailed that it is a fundamental problem of QCA that there are no standardized and generally known and accepted criteria on how to perform a qualitatively 'good' QCA analysis. On the one hand, this refers to the technically correct application of QCA. Although one should think that an adequate technical knowledge is a minimum requirement for running QCA, there is enough evidence that this is not always the case. In this, QCA is very similar to statistical procedures whose users often apply their rudimentary basic knowledge to rather complicated analyses, and who, in the consequence, do not respect many conditions and requirements (just think about the often omitted regression diagnostics or the rather innocent application of linear regression techniques, no matter, if research question and the level of variables are suitable for them, or not). On the other hand, the aspect of high-quality QCA analysis also also extends to the procedure *before* and *after* the 'analytic moment' of data analysis. Neglecting this reduces QCA to pure data manipulation and violates the 'Q' in QCA, which, we should remember, stands for *qualitative* comparative analysis. Our list of good practices from A to Z is organized in six parts and makes proposals that refer to both aspects of QCA.

In conclusion, we like to emphasize that we deem it important that neither of our points turns into unreflected dogma. Useful suggestions turned into mechanically applied operations loose much of their positive effects. Mindless application of 'standards of good practice' eliminates their positive contributions to an improved transparency and comparability of studies, and adds to this the negative effect of creating a normative force through the repeated application by the majority of users, a status which they in reality do not deserve. Insofar, our paper aimed at collecting some criteria and practices and to initiate a debate, which, hopefully, sharpens the attention for methodological problems, which, in part go well beyond QCA only. Also other techniques (and their methodological and epistemological foundations) should never only be treated as 'tools'. What is needed is rather a critical reflection about the methodical necessities, the readiness for an adaptation of the methodological possibilities, and a conscious application of the methodological repertoire. Certainly, this requires a certain investment of time and intellectual capacities. However, it also implies that the researchers can feel more assured about their research results – in the end, it is them to dominate methods, and not *vice versa*.

Thus, the hope remains that QCA applicants will follow a way of responsible, reflexive and serious application of methods. QCA is still young (and not diffused) enough to avoid a blind adoption of standardized rules.

References

Brady, Henry E., and David Collier. 2004. *Rethinking Social Inquiry: Diverse Tools, Shared Standards*. Lanham: Rowman&Littlefield.

Braumoeller, Bear F. 2003. Causal Complexity and the Study of Politics. *Political Analysis* 11(3):209-233

Braumoeller, Bear F., and Gary Goertz. 2003. The Statistical Methodology of Necessary Conditions. In *Necessary Conditions: Theory, Methodology, and Applications* , edited by Goertz, Gary, and Harvey Starr. (Lanham, Md., Boulder: Rowman & Littlefield).

Caren, Neal, and Aaron Panofsky. 2005. TQCA. a Technique for Adding Temporality to Qualitative Comparative Analysis. *Sociological Methods & Research* 34(2):147-172

Collier, David, and Henry E. Seawright Jason Brady. 2004. Sources of Leverage in Causal Inference. In *Rethinking Social Inquiry: Diverse Tools, Shared Standards*, edited by Brady, Henry E., and David Collier. (Lanham: Rowman&Littlefield).

Collier, David, James Mahoney, and Jason Seawright. 2004. Claiming Too Much: Warnings About Selection Bias. In *Rethinking Social Inquiry: Diverse Tools, Shared Standards*, edited by Brady, Henry E., and David Collier. (Lanham: Rowman&Littlefield).

Cronqvist, Lasse.2005. *Introduction to Multi-Value Qualitative Comparative Analysis (MVQCA)*. Marburg. Internet: http://www.tosmana.net.

Cronqvist, Lasse.2006. *Tosmana - Tool for Small-N Analysis [SE Version 1.25]*. Marburg. Internet: http://www.tosmana.net.

De Meur, Gisele, and Benoit Rihoux. 2002. *L'Analyse Quali-Quantitative Comparee. Approche, Techniques Et Applications En Sciences Humaines*. Louvain-La-Neuve: Bruylant Academia.

Dion, Douglas. 2003. Evidence and Inference in the Comparative Case Study. In *Necessary Conditions: Theory, Methodology, and Applications* , edited by Goertz, Gary, and Harvey Starr. (Lanham, Md., Boulder: Rowman & Littlefield).

Dusa, Adrian.2007. *QCA Graphical User Interface Manual*. Compasss Working Paper, WP 2007-50.

Goertz, Gary. 2003. The Substantive Importance of Necessary Condition Hypotheses. In *Necessary Conditions*, edited by Goertz, Gary, and Harvey Starr. (Lanham: Rowman & Littlefield Publishers).

Goertz, Gary. 2006. Assessing the Trivialness, Relevance, and Relative Importance of Necessary and Sufficient Conditions in Social Science. *Studies in Comparative International Development* 41(2)

Goertz, Gary, and Harvey Starr. 2003. *Necessary Conditions: Theory, Methodology, and Applications* . Lanham, Md., Boulder: Rowman & Littlefield.

Goldthorpe, John H. 1997. Current Issues in Comparative Macrosociology: a Debate on

Methodological Issues. *Comparative Social Research* 16:1-26

Hall, Peter A. 2003. Aligning Ontology and Methodology in Comparative Politics. In *Comparative Historical Analysis in the Social Sciences*, edited by Mahoney, James, and Dietrich Rueschemeyer. (Cambridge/New York: Cambridge University Press).

King, Gary, Robert O. Keohane, and Sidney Verba. 1994. *Designing Social Inquiry. Scientific Inference in Qualitative Research*. Princeton: Princeton University Press.

Klir, George J., Ute St. Clair, and Bo Yuan. 1997. *Fuzzy Set Theory. Foundations and Applications*. Upper Saddle River, NJ: Prentice Hall PTR.

Kosko, Bart. 1993. *Fuzzy Thinking: the New Science of Fuzzy Logic*. New York: Hyperion.

Lieberson, Stanley. 1985 . *Making It Count: the Improvement of Social Research and Theory*. Berkeley: University of California Press.

Mackie, John L. 1974. *The Cement of the Universe*. Oxford: Oxford University Press.

Mahoney, James. 2003a. Knowledge Accumulation in Comparative Historical Research: the Case of Democracy and Authoritarianism. In *Comparative Historical Analysis in the Social Sciences*, edited by Mahoney, James, and Dietrich Rueschemeyer. (Cambridge: Cambridge University Press).

Mahoney, James. 2003b. Strategies of Causal Assessment in Comparative Historical Analysis. In *Comparative Historical Analysis in the Social Sciences*, edited by Mahoney, James, and Dietrich Rueschemeyer. (Cambridge: Cambridge University Press).

Marx, Axel.2006. *Towards More Robust Model Specification in QCA. Results From a Methodological Experiment*. Compasss Working Paper, WP 2006-43.

Mill, John Stuart. 1865. Of the Four Methods of Experimental Inquiry. In *System of Logic, Ratiocinative and Inductive, Vol. 1, Book 3, Chap. VIII, Sixth Edition*, edited by Mill, John Stuart.

Morlino, Leonardo. 2005. *Introduzione Alla Ricerca Comparata*. Bologna: Il Mulino.

Ragin, Charles C. 1987. *The Comparative Method. Moving Beyond Qualitative and Quantitative Strategies*. Berkeley/Los Angeles/London: University of California Press.

Ragin, Charles C. 2000. *Fuzzy-Set Social Science*. Chicago: University of Chicago Press.

Ragin, Charles C.2003a. *Making Comparative Analysis Count*. Compasss Working Paper, WP 2003-6.

Ragin, Charles C.2003b. *Recent Advances in Fuzzy-Set Methods and Their Application to Policy Questions*. Compasss Working Paper, WP 2003-5.

Ragin, Charles C. 2004. Turning the Tables: How Case-Oriented Research Challenges Variable-Oriented Research. In *Rethinking Social Inquiry: Diverse Tools, Shared*

Standards, edited by Brady, Henry E., and David Collier. (Lanham: Rowman&Littlefield).

Ragin, Charles C. 2006a. The Limitations of Net-Effect Thinking. In *Innovative Comparative Methods for Policy Analysis. Beyond the Quantitative-Qualitative Divide*, edited by Rihoux, Benoit, and Heike Grimm. (New York: Springer).

Ragin, Charles C. 2006b. Set Relations in Social Research: Evaluating Their Consistency and Coverage . *Political Analysis* 14(3):291-310

Ragin, Charles C. 2007. Qualitative Comparative Analysis Using Fuzzy Sets (FsQCA). In *Configurational Comparative Methods*, edited by Rihoux, Benoit, and Charles C. Ragin. (Thousand Oaks/London: Sage).

Ragin, Charles C. forthcoming. Fuzzy Sets: Calibration Versus Measurement. In *Methodology Volume of Oxford Handbooks of Political Science*, edited by Collier, David, Henry Brady, and Janet Box-Steffensmeier.

Ragin, Charles C., and Howard S. Becker. 1992. *What Is a Case? Exploring the Foundations of Social Inquiry*. Cambridge: Cambridge University Press.

Ragin, Charles C., Drass, Kriss A., and Davey, Sean.2006. *Fuzzy-Set/Qualitative Comparative Analysis 2.0*. Tucson, Arizona: Department of Sociology, University of Arizona.

Ragin, Charles C., and Benoit Rihoux. 2004. Qualitative Comparative Analysis (QCA): State of the Art and Prospects. *Qualitative Methods. Newsletter of the American Political Science Association Organized Section on Qualitative Methods* 2(2):3-12

Ragin, Charles C., and John Sonnett. 2004. Between Complexity and Parsimony: Limited Diversity, Counterfactual Cases, and Comparative Analysis. In *Vergleichen in Der Politikwissenschaft*, edited by Kropp, Sabine, and Michael Minkenberg. (Wiesbaden: VS Verlag für Sozialwissenschaften).

Ragin, Charles C., and Strand, Sarah.2007. *Using QCA to Study Causal Order: Comments on Caren and Panofsky (2005)*. Compasss Working Paper, WP 2007-45.

Rihoux, Benoit, and Charles C. Ragin. 2007a. *Configurational Comparative Analysis*.: Sage Publications.

Rihoux, Benoit, and Charles C. Ragin. 2007b. *Configurational Comparative Methods*. Thousand Oaks/London: Sage.

Scharpf, Fritz W. 2000. *Interaktionsformen. Akteurzentrierter Institutionalismus in Der Politikforschung*. Opladen: Leske+Budrich.

Schneider, Carsten Q. 2006. Qualitative Comparative Analysis Und Fuzzy Sets. In *Methoden Der Politikwissenschaft: Neuere Quantitative Und Qualitative Analyseverfahren*, edited by Behnke, Joachim, Thomas Gschwend, Delia Schindler, and Kai-Uwe Schnapp. (Baden-Baden: Nomos).

Schneider, Carsten Q. forthcoming. Issues in Measuring Political Regimes. In *Measuring Democratic Transition*, edited by Greene, Sam, and N. Petrov. (Moscow: Carnegie Moscow Center).

Schneider, Carsten Q., and Grofman, Bernard.2006. *It Might Look Like a Regression ... but It's Not! An Intuitive Approach to the Presentation of QCA and Fs/QCA Results*. Compasss Working Paper, WP2006-39.

Schneider, Carsten Q., and Claudius Wagemann. 2006. Reducing Complexity in Qualitative Comparative Analysis (QCA): Remote and Proximate Factors and the Consolidation of Democracy. *European Journal of Political Research* 45(5):751-786

Schneider, Carsten Q., and Claudius Wagemann. 2007. *Qualitative Comparative Analysis (QCA) Und Fuzzy Sets. Ein Lehrbuch Für Anwender Und Alle, Die Es Werden Wollen*.: Verlag Barbara Budrich.

Smithson, Michael, and Jay Verkuilen. 2006. *Fuzzy Set Theory: Applications in the Social Sciences*. Thousand Oaks : Sage Publications.

Vanderborght, Yannick, and Yamasaki, Sakura.2003. *The Problem of Contradictory Simplifying Assumptions in Qualitative Comparative Analysis (QCA)*. Paper presented at the ECPR General Conference, Marburg, 18-21 September.

Wagemann, Claudius. 2007 . Qualitative Comparative Analysis Und Policy-Forschung. edited by Janning, Frank, and Katrin Toens.

Walker, Henry A., and Bernard P. Cohen. 1985 . Scope Statements: Imperatives for Evaluating Theory. *American Sociological Review* 50(3):288-301

Yamasaki, Sakura.2003. *Testing Hypotheses With QCA: Application to the Nuclear Phase-Out Policy in 9 OECD Countries*. Paper presented at the ECPR General Conference, Marburg, 18-21 September.

Zadeh, Lofti A. 1965. Fuzzy Sets. *Information and Control* 8:338-353

Zadeh, Lofti A. 1968. Fuzzy Algorithms. *Information and Control* 12:99-102