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9 Qualitative comparative analysis and the study of non-state actors

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Introduction

Suppose you wanted to find out under what conditions non-state actors (NSAs) rebel against state authorities or to investigate what factors lead governments to contract private military and security companies (PMSCs). For these and similar research aims there will rarely be a single cause to account for the outcome. Instead, you might discover that multiple factors bring about the phenomenon of interest and that these interact in specific ways. Qualitative Comparative Analysis (QCA) is ideally suited to analyse these kinds of causal relations, especially if the aim is to conduct a comparative study of at least a medium number of cases. Two particular strengths of QCA are its ability to account for *equifinality* and *conjunctural causation*. The first concept relates to the potential presence of alternate pathways towards an outcome, and the second concerns the idea that configurations of conditions can be jointly necessary and/or sufficient for an outcome. *Fuzzy sets* complement QCA as a methodological tool for translating categorical concepts into measurable conditions, drawing on the notion that cases can hold degrees of membership in a given set.

QCA was introduced and further developed by the sociologist Charles Ragin (1987, 2000, 2008). Recent textbooks indicate that QCA has gained recognition among social scientists as a methodological approach that offers specific benefits for comparative studies (Blatter and Haverland 2012; Gerring 2012; Rohlfing 2012; Schneider and Wagemann 2012). From its inception, QCA was aimed at the ‘middle ground’ between quantitative and qualitative methodologies (Ragin 2000: 22). In contrast to regression-based statistical approaches, QCA is based on *set theory*; as such, it investigates the specific conditions under which an outcome occurs rather than estimating the ‘average effects of independent variables’ (Mahoney 2010: 132). Hence, causal relations are expressed in terms of necessary and sufficient conditions – a ‘substantively important’ view of causation that has recently gained increased attention in the social sciences (Collier *et al*. 2010: 147).

Most of the existing QCA applications in international security, and in International Relations (IR) more generally, compare countries or national governments as their cases or units of observation. Hence, QCA has at times been equated with an approach that is exclusively macro-comparative. Contrary to this view, however, there are no inherent methodological reasons why QCA cannot be applied to the study of NSAs. Equifinality and conjunctural causation are just as relevant when it comes to researching NSAs in international security. For example, many of the explanations for the outbreak or termination of civil war or states' use of PMSCs combine several conditions and specify alternative pathways to the same outcome. Moreover, as a rigorous comparative method, QCA offers advantages over some alternative approaches.

Yet, as outlined by Andreas Kruck and Andrea Schneiker in the introduction to this volume (see Chapter 1), there are challenges when it comes to research on NSAs in international security, specifically when the aim is to conduct a *comparative* study. Without doubt, the greatest of these is the problem of finding *reliable* and *comparable* data on NSAs. This problem also exists in other substantive fields, but the security realm is notorious for having inaccessible and unreliable data, which is why many studies in this area have focused on a single case or a small number of cases, based on in-depth qualitative information. However, an advantage of QCA is that researchers can draw equally on qualitative *and* quantitative sources of data, depending on their specific research aim and the kind of information required to operationalize their theoretical framework. Whereas statistical approaches require standardized data, QCA allows for more flexibility on the part of the researcher in terms of using unstandardized sources of information or case-specific indicators. This can be achieved through the calibration of crisp and fuzzy sets, a process that forms the backbone of any set-theoretic analysis. Thus, although QCA has been rarely used to study NSAs in the field of international security, it holds considerable potential as a way to enrich the portfolio of methods currently employed in this research area.

The aim of this chapter is twofold. The first part introduces the methodological approach of QCA, including its core principles, specific terminology and analytical procedures. While this methodological discussion may appear rather dense to readers unfamiliar with this approach, the second part of the chapter is intended to illuminate the research process of a study that used QCA, showing step-by-step how some of the somewhat abstract 'nuts and bolts' translate into an empirical study. This second part draws on my own work on democratic participation in armed conflict (Mello 2012, 2014). The demonstration of QCA in use should provide helpful guidance for conducting medium-*N* research on NSAs. The final section briefly covers some of the advantages and challenges of applying this analytical method.

Principles and terminology of QCA

Crisp and fuzzy sets

Although there are several variants of QCA, the most popular ones are crisp-set QCA and, increasingly so, fuzzy-set QCA (fsQCA). Crisp sets take on binary values, whereas fuzzy sets can take on any value between 0 and 1. Which of these should be applied will depend on the research aim of a given project, but in many cases there will be advantages to using fuzzy sets. Fuzzy-set theory was developed by Lotfi Zadeh (1965) as an extension of traditional set theory. Based on the notion that cases can hold degrees of membership in a given set, fuzzy sets enable the researcher to translate categorical concepts into measurable conditions. Thus, fsQCA allows for qualitative differentiation: on the basis of substantive and theoretical knowledge, the researcher establishes 'qualitative anchors' to determine whether a case is 'fully in' a given set (fuzzy score 1), whether it is 'neither in nor out' (fuzzy score 0.5) and at what point a case is 'fully out' of a set (fuzzy score 0). This set-theoretic conception and calibration procedure challenges an assumption often made in statistical research; that is, where all variation is held to be equally meaningful (Ragin 2000: 163).

Three different procedures are possible for the *calibration* of fuzzy sets. In the straightforward approach, fuzzy scores are assigned to cases on the basis of substantive and theoretical knowledge. Using this approach, a researcher would first conceptualize different degrees of membership in a given set and then qualitatively assess the fuzzy score of each case. Other coding procedures are the 'direct' and 'indirect' methods of calibration (Ragin 2008: 85–105), which become relevant only when quantitative data are used. For example, a study interested in the severity of non-state armed conflicts could draw on various forms of qualitative information (interviews, reports, secondary sources, etc.) or could use an existing data set, such as the information provided by the Uppsala Conflict Data Program (UCDP), which could prove particularly beneficial when the aim is to conduct a larger comparative study.

Both direct and indirect methods use statistical estimation techniques to transform interval-scale variables into fuzzy-set scores. The direct method of calibration applies a logistic function to transform raw data into fuzzy-set values based on three qualitative breakpoints specified by the researcher (Ragin 2008: 89–94). As the name implies, the indirect method of calibration includes an additional step that necessitates a preliminary qualitative grouping of cases according to their degree of membership. In turn, a fractional logit model is used to estimate fuzzy-set values based on the raw data and the initial qualitative coding of cases (Ragin 2008: 94–97). It is apparent from these procedures that, despite their dissimilarities, all calibration procedures require careful *conceptualization* of qualitative anchors. Hence, even for 'semi-automated calibration techniques', substantive knowledge is a prerequisite for the coding of fuzzy sets (Schneider and Wagemann 2012: 41).[1]

Boolean algebra

QCA is grounded in Boolean algebra, originated by George Boole, a nineteenth-century British mathematician and logician who developed an algebra for variables that have only two possible values: true (present) or false (absent). By convention, QCA solution terms are expressed in Boolean notation, which comprises several basic operators. Explanatory and outcome conditions are stated in capital letters, whereas a tilde [~] refers to a logical NOT, as in the negation or absence of a condition. Multiplication [*] refers to a logical AND, or the combination of conditions, whereas addition [+] indicates a logical OR, as in alternative pathways. Finally, arrows express the relationship between one or several explanatory conditions and the outcome. Accordingly, a rightwards arrow [→] refers to a sufficient condition, whereas a leftwards arrow [←] indicates a necessary condition.

For example, the civil war literature considers economic motives [E] and injustice [I] to be drivers of rebellion. However, to be sufficient for the outbreak of civil war [W], these factors must combine with a potential rebel group's opportunity to form an armed movement, which depends on the presence of financial resources [R] and popular support [S]. In Boolean notation, these alternative pathways would be expressed as: (E*R*S)+(I*R*S)→W. This indicates that the conjunctions ERS and IRS are both sufficient for the outbreak of civil war.

Set-theoretic methods are governed by three simple mathematical principles that can be applied equally to crisp sets and fuzzy sets.

First, the *negation* of set values is calculated by subtracting the membership value of a case in a given set from 1. If case A holds a fuzzy membership value of 0.3 in set Y, then its value for ~Y is 0.7.

Second, the combination of conditions, a *logical AND*, refers to the minimum membership values in the respective conditions. For instance, assuming we wanted to calculate the membership of case A in the combination of the fuzzy sets B and C. If A's membership in B were 1.0 (fully in the set) but its set membership in C were 0.2 (mostly outside the set), then membership in the combination of these conditions B*C would be the lower of the two values (0.2). This set-theoretic principle contrasts with quantitative approaches that would calculate the *average* value between the two conditions. However, with regard to their membership in a given combination, no difference exists between cases with membership scores outside only one or both sets of the respective combination.

Finally, the third principle is the *logical OR*, which reflects the presence of alternative conditions and thus refers to the *maximum* of the respective membership values. For example, this could be the case when two conditions, A and B, individually lead towards an outcome. Hence, a case's fuzzy-set membership in the term (A+B), as in 'A OR B', refers to the case's highest membership score across the two conditions.

Complex causation

As a set-theoretic method, QCA interprets relationships between social phenomena in terms of necessary and sufficient conditions. This perspective on causal relations entails three methodological assumptions: equifinality, conjunctural causation and causal asymmetry. Together, these constitute 'complex causation', a specific asset of QCA (Ragin 2008: 78; Schneider and Wagemann 2012). In a nutshell, QCA allows for the possibility that different pathways

Table 9.1 INUS and SUIN causes

A and B as INUS causes	*F and G as SUIN causes*
$AB+C \rightarrow Y_1$	$D \leftarrow Y_2$ $F+G \rightarrow D$

Source: own table.

towards the same outcome exist (*equifinality*); that two or more conditions can jointly cause an outcome to occur (*conjunctural causation*); and that an identified relationship between a condition and the outcome does not mean that the inverse relationship must also be true (*causal asymmetry*).

In social science research, however, it is apparent that conditions are seldom *individually* necessary and/or sufficient for an outcome. By contrast, 'INUS' and 'SUIN' causes are found frequently, although causal explanations are not often framed in these terms. INUS denotes 'an *insufficient* but *necessary* part of a condition, which is itself *unnecessary* but *sufficient* for the result' (Mackie 1965: 245, emphases in the original). SUIN refers to 'a *sufficient* but *unnecessary* part of a factor that is *insufficient* but *necessary* for an outcome' (Mahoney *et al.* 2009, emphases in the original). It follows from the definition of INUS causes that these are present whenever equifinality and conjunctural causation *combine*, meaning that at least two pathways towards an outcome exist and that at least one of them comprises more than a single condition. In turn, SUIN causes can be understood as equivalent indicators that *constitute* a necessary condition, where each individual element is unnecessary but sufficient for the condition. Table 9.1 shows the relationship in formal notation. The conditions A and B are INUS causes for the outcome Y_1; the conditions F and G are sufficient conditions for D, which is a necessary condition for the outcome Y_2.

The third methodological assumption, causal asymmetry, implies that the solution for the *non*-outcome cannot with certainty be derived from the solution for the outcome. Therefore, it is considered 'good practice' to conduct separate analyses for the outcome and its negation (Schneider and Wagemann 2010: 408–409). This procedure can also serve to validate a theoretical claim – if a specific conjunction leads consistently towards the outcome but *also* leads towards the non-outcome, doubts arise about its explanatory strength. Moreover, a meaningful analysis of the non-outcome requires the inclusion of *negative cases*, which can strengthen confidence in the QCA results for both analyses (Mello 2013: 13–14).

Measures of consistency and coverage

Fuzzy-set analysis introduces the measures of *consistency* and *coverage* to assess whether a single condition or a conjunction of several conditions is necessary and/or sufficient for an outcome.[2] Whereas consistency reflects the *fit* of the empirical evidence with an assumed set-theoretic relationship, coverage indicates the *relevancy* of a condition in empirical terms. For the analysis of sufficiency, set-theoretic *consistency* indicates the extent to which instances of a combination of conditions are a subset of instances of the outcome. Formally speaking, if all values for Y are equal to or less than their corresponding values for X, then Y is a subset of X and thus X is a *necessary condition* for the outcome. In turn, if all values for X are equal to or less than their corresponding values for Y, then X resembles a subset of Y and is thus a *sufficient condition* for that outcome.

The calculation of set-theoretic *coverage* is inversely related to the consistency measure. This implies that the coverage of a sufficient combination of conditions indicates the size of the empirical overlap, or the proportion of instances of the outcome that are explained by the given combination. Although conjunctions with several conditions are likely to show higher consistency scores, their empirical relevance will tend to decrease, because there will be fewer empirical cases that fit the described causal path. In turn, for a necessary condition, the coverage value reflects the fit between instances of that condition and the outcome. Even though a condition could be a perfectly consistent superset and thus a necessary condition in formal terms, it may be *irrelevant* in theoretical terms if the condition is present across cases that show the outcome and among cases that do not show the outcome.

Truth table analysis

How do these concepts and principles translate into the analysis? The core of the QCA procedure contains two steps. First, a *truth table* is constructed that contains rows for each logical combination of conditions and indicates which cases belong to a configuration and how these relate to the outcome. Hence, the fuzzy-set truth table represents a multidimensional vector space with 2^k corners, where k relates to the number of conditions and each corner of the resulting property space signifies a distinct combination of conditions, represented by a separate row in the truth table. For example, if four conditions are part of the analysis, the truth table comprises 2^4, or 16, rows. Based on their fuzzy-set membership scores for each condition in a respective combination, cases can be assigned to distinct corners of the property space (Ragin 2008: 124–135). The consistency column of the truth table indicates the extent to which the fuzzy-set values of all cases in a given row or conjunction are sufficient for the outcome. Based on the consistency scores, the researcher determines a cut-off point to indicate which rows will be included for the remainder of the truth table procedure (Ragin 2008: 135).

The second step involves the *logical minimization* of the truth table, which is required to identify sufficient conditions. Here, Boolean algebra is applied to minimize the truth table and identify combinations of conditions that are sufficient for the outcome (Ragin 1987: 937). In QCA, this is done by means of the Quine–McCluskey algorithm, also known as the truth table algorithm. It requires

Table 9.2 Example of a truth table

Conditions			*Outcome*	*Cases*
X	*Y*	*Z*	*O*	*N*
1	1	1	1	3
1	1	0	1	2
1	0	0	0	1
1	0	1	0	2
0	1	1	0	1
0	1	0	0	3
0	0	1	0	1
0	0	0	0	2

Source: own table.

the researcher to set a consistency threshold that determines which truth table rows will be included in the ensuing minimization procedure. By convention, this threshold should be set to a consistency of at least 0.75.

To illustrate the construction of truth tables with a simple crisp-set example, let us assume we have three conditions that are expected to cause an outcome, either in combination with other conditions or individually. Table 9.2 shows all logical combinations of conditions X, Y and Z and their empirical relation to the outcome O based on 15 cases across the eight possible configurations. The right-hand column shows us how many empirical cases fall into each configuration of conditions (i.e. truth table rows). It is apparent from the table that only the first two rows will lead towards the outcome. In Boolean algebra, this is expressed as (X*Y*Z)+(X*Y*~Z)→O. Based on logical minimization, this complex expression can be further reduced to (X*Y)→O, because the condition Z is irrelevant for the outcome, since O occurs in Z's presence (see row 1) and its absence (see row 2), whereas X and Y are necessary elements of a conjunction that is sufficient for O. This simple example serves to illustrate the basic principle of comparison that is embedded in QCA. When fuzzy sets are used and further conditions are added, the analysis becomes increasingly complex, justifying a systematic treatment that can be conducted with the appropriate software, as will be discussed below.

Limited diversity

During the truth table analysis, most applications of QCA will encounter the phenomenon of *limited diversity*, which refers to the discrepancy between logically possible combinations of conditions (conjunctions) and the actual empirical cases in a given study. This problem increases as more conditions are included. For example, imagine a study that seeks to explain the contracting of PMSCs in 12 conflicts on the basis of five explanatory conditions. As discussed in the previous section, this would imply that there are 2^5, or 32, distinct combinations of conditions. Hence, because of the number of cases (conflicts) included, this design would yield *at least* 20 'logical remainders' in the truth table rows not filled with empirical information; that is, if one assumes that each case shows a distinct combination of conditions (which would be a rather bold assumption). Although the phenomenon of limited diversity is ubiquitous in social research, QCA allows for analytical strategies that deal with logical remainders.[3] It is therefore important for researchers to be aware of these strategies to avoid drawing unwarranted conclusions during analysis.

The QCA research process: an illustration

The remainder of this chapter will illustrate a QCA research process by drawing on my study of democratic involvement in the Iraq War (Mello 2014: Chapter 7). The study sought to explain the military participation (and non-participation) of 30 democracies in the ad hoc coalition that was established for the Iraq War in 2003. Rather than seeking a monocausal explanation for the observed phenomenon, my approach was directed towards theoretical integration, drawing on liberal, institutionalist, constructivist and neorealist explanations. The decision in favour of eclecticism was partly a response to prevalent accounts of the Iraq War, in which various factors were being highlighted as 'causes' but a more comprehensive explanation of military involvement was not given. Moreover, it was apparent that *interaction* between certain conditions had been overlooked, something that QCA promised to capture quite well. There are good reasons to assume that many research projects on NSAs in international security will face similar challenges and pursue comparable aims. Thus, the following reflections on the application of QCA to the study of democratic war should encourage, and is apt to guide, QCA-based research on NSAs.

Conceptualizing the outcome

For any causal research design, the first step is to specify the outcome (or dependent variable): what is to be explained? In my case, it soon became apparent that the measurement of 'military participation' in the Iraq War was more difficult than I had imagined when I started the project. First, there were qualitative differences in the types of military contributions. Several countries sent military engineers, others deployed ground transportation units, and some dispatched military police to Iraq. Should all these contributions be considered 'war involvement'? Moreover, there were immense quantitative differences in the number of troops made available. For example, Estonia deployed an infantry platoon of 55 soldiers, whereas the United Kingdom sent nearly 50,000 troops to Iraq. How does one take this variation into account? Crucially, there was the dimension of time. The United States, the United Kingdom, Poland and Australia were the only countries involved in the immediate invasion in March 2003, but many other countries contributed during the following weeks and months. But where does one draw the line to distinguish military participation from other forms of involvement?

Rather than using binary coding to distinguish participation and non-participation, I decided to construct a fuzzy set, designated ‘military participation’ (MP), that allowed me to take into account the qualitative and quantitative differences in military contributions from the various countries. But I still needed a distinguishing criterion to decide whether a case was rather ‘inside’ (values larger than 0.5) or rather ‘outside’ (values lower than 0.5) the fuzzy set ‘MP’. I based this on whether or not a country’s deployment included ground troops with combat tasks – a criterion that goes to the heart of the debate about the use of military force by democracies. The number of troops and the timing of the deployments then allowed me to make further distinctions. The resulting fuzzy set MP ranged from countries such as Finland, which did not contribute (fuzzy score 0), to Belgium, which granted overflight rights (fuzzy score 0.1), to the Czech Republic, which had contributed a military field hospital (fuzzy score 0.4), to the United States, which contributed the most (fuzzy score 1.0). Table 9.3 shows the information that went into the coding of some of the selected countries (abbreviated for presentational purposes).

Selecting explanatory conditions

The selection of explanatory conditions is central to any study that uses QCA. From a theoretical point of view, the inclusion of a large number of conditions can often be desirable; however, adding further conditions will in all likelihood increase the problem of *limited diversity*, because the number of possible combinations of conditions will rise exponentially with each additional condition, resulting in fewer or no empirical cases for each row in the truth table.

In my study, like many researchers, I also faced the challenge of selecting from a potentially boundless number of factors offered by the various IR theories. I approached this problem by subsuming prevalent factors in the literature on democratic war under three broad approaches: institutional constraints, political preferences and external constraints and inducements (Mello 2014: Chapter 2). I then settled for a theoretical framework that included five explanatory conditions: (1) parliamentary veto rights, (2) constitutional restrictions, (3) executive partisanship, (4) public support and (5) military power. In line with previous work on democratic peace, which formed the backdrop to my research project, these conditions emphasized domestic factors but also included a neorealist condition based on the distribution of material capabilities among the included countries.

Of my six conditions (five explanatory conditions and the outcome), three were calibrated based on *qualitative* information by developing a coding scheme and assigning values to each case (based on country-specific research, government documents, secondary sources, news agencies, etc.). The other three conditions were coded using the ‘direct method of calibration’, which transforms raw data into calibrated fuzzy sets (on this procedure, see Ragin 2008: 85–105). For these conditions, I drew on *quantitative* data from the Comparative Manifesto Project (CMP) (Budge *et al.* 2001), various public opinion polls and military expenditure statistics.

Table 9.3 The fuzzy set 'military participation' in the Iraq War (outcome)

Country	*MP*	*Phase*	*Type*	*Deployment*	*Contribution*	*Troops*
United States	1.0	Invasion	Combat	03–2003	Army, naval, air force units	150,816
Spain	0.9	Post-invasion	Combat	04–2003	Marine infantry, support units	1300
Italy	0.8	Post-invasion	Combat	07–2003	Mechanized infantry, helicopters	2400
Czech Republic	0.4	Post-invasion	Non-combat	05–2003	Military field hospital, military police	110
Norway	0.3	Post-invasion	Non-combat	07–2003	Mine clearance	150
New Zealand	0.2	Reconstruction	Non-combat	09–2003	Engineers, reconstruction	61
Belgium	0.1	–	Logistical	–	Overflight rights	–
Finland	0.0	–	–	–	None	–

Source: own table, based on Mello (2014: 159–163).

Note
MP is the fuzzy set military participation. Table shows only selected cases for presentational purposes, for a full documentation see Mello (2014: 159–163).

Table 9.4 Fuzzy-set calibration

		Austria	*Italy*	*Japan*	*Latvia*	*Spain*
Qualitative fuzzy sets	Military participation (Outcome)	0.00	0.80	0.20	0.90	0.90
	Parliamentary veto rights	1.00	0.60	0.60	1.00	0.00
	Constitutional restrictions	1.00	0.20	1.00	0.20	0.00
Quantitative fuzzy sets	Public support	0.02	0.06	0.08	0.02	0.04
	Right executive	0.51	0.96	0.66	0.38	0.66
	Military power	0.15	0.63	0.87	0.13	0.25
Raw data	Public support (%)	8.00	18.00	20.00	7.00	12.00
	Executive L-R (CMP data)	0.80	53.83	11.12	–7.92	11.42
	Military expenditure (bn US$)	1.80	25.60	39.50	0.15	8.70

Source: own table, based on Mello (2014, Chapter 7).

Note
Table shows only selected cases for presentational purposes, for a full documentation see Mello (2014: Chapter 7).

Table 9.4 lists the conditions of my study and shows the resulting values for five out of 30 countries. The upper three rows show fuzzy sets based on qualitative information. The lower six rows show fuzzy sets that were based on quantitative and raw data; for these data I used the direct method of calibration, after having first defined three qualitative breakpoints for each set. For the left–right (L–R) partisanship CMP data, I used breakpoints of −50 (fully out), 0 (cross-over) and 50 (fully in). Although the CMP data can take on values between −100 (all leftist statements in the party manifesto) and 100 (all rightist statements), empirical cases rarely come close to the theoretical end points of this continuum. Hence, I decided that values of 50 and −50 would be sufficient for deciding what was 'fully in' or 'fully out' of the respective sets. As a result of these coding decisions, Latvia was rather outside the set 'right executive' (0.38), whereas Italy received a value of 0.96 and could thus be considered almost 'fully in' the set of right executives.

Formulating hypotheses

QCA can be used in different ways, but most studies employ this method to test established or refined hypotheses or theories.[4] However, because QCA investigates the specific conditions under which an outcome occurs rather than the average effect of a set of independent variables, hypotheses need to be framed in terms of necessary and sufficient conditions. This can pose a problem when the research goal is to test established probabilistic hypotheses. Although a large body of work in the social sciences rests on a (sometimes implicit) understanding of necessary and sufficient causation (Goertz 2003b), many hypotheses in the literature continue to be framed in probabilistic language, requiring prior 'translation' on the part of the researcher who seeks to employ such hypotheses in an fsQCA procedure (Goertz 2003a).

In my study, I formulated two hypotheses for each condition, many of which were conceived as INUS causes (see above). Put in simple terms, this meant that the given condition was expected to cause the outcome when *combined* with other conditions. For others, the expectations derived from the literature were more concrete, so I expected a specific conjunction to be a sufficient condition for the outcome. Here are three examples (Mello 2014: 34):

- 'Parliamentary veto rights combined with public opposition are a sufficient condition for military non-participation.'
- 'Constitutional restrictions are a sufficient condition for military non-participation.'
- 'Right partisanship is an INUS condition for military participation.'

Analysis of necessary conditions

The stages just described are still part of the research design; the QCA data analysis proper involves a sequence of steps, all of which can be carried out with the use of appropriate software. Until recently, the most widely used program for this purpose was fsQCA 2.5, which can perform the essential tasks but is limited in terms of reliability, advanced functions and user-friendliness. Among existing alternatives, the most promising is the QCA package for R (Thiem and Duşa, 2013), currently in version 1.1–49.[5] In addition, a graphic user interface for R (QCAGUI) is under development and will greatly enhance the accessibility of R, especially for users who are not familiar with that environment.

The QCA procedure should always begin with a test for necessary conditions. In set-theoretic terms, a necessary condition is given when instances of the outcome are a subset of instances of a condition. As a rule of thumb, the consistency threshold for *potential* necessary conditions should be set to 0.90 (Schneider and Wagemann 2012: 143). To test for necessary conditions, I applied the formulas for consistency and coverage on each individual condition and its negation for the outcome and the non-outcome (using fsQCA for this purpose). This procedure revealed that the absence of constitutional restrictions (~C) was a necessary condition for military participation, at 0.94 consistency and 0.64 coverage. This finding supported my expectation that military participation required a lack of constitutional restrictions and, conversely, implied that constitutional restrictions amounted to a structural veto against military participation. The calculations further showed that the absence of public support was necessary for both outcomes, at 0.99 consistency for military non-participation and 0.97 consistency for military participation. Yet, given the near unanimous public opposition to the Iraq War across the observed democracies, this finding was far from surprising. As the respective coverage scores of 0.50 and 0.55 indicated, the inferential value of this necessary condition was rather limited.

Truth table analysis

During the next step, I constructed a truth table for the outcome 'military participation' (Table 9.5). Because the model included five conditions, the resulting truth table comprised $2^{5\ (M,\ V,\ C,\ S,\ E)}$, or 32, rows. However, because of *limited diversity*, only 12 of these rows contain empirical cases, whereas the others are logical remainders. These represent combinations of conditions that can be included in an *intermediate solution* produced by the software, if one can formulate plausible assumptions about their potential outcome even when these are not empirically observed. Table 9.5 shows the resulting truth table for military participation in the Iraq War.

Each country's membership in the respective conjunction of conditions is given in parentheses. Italy, for instance, holds a membership of 0.60 in the conjunction given in the first row, which comprises the presence of military power, parliamentary veto rights and a right executive, combined with the absence of constitutional restrictions and public support. The consistency column indicates the extent to which the fuzzy-set values of all cases in a conjunction are sufficient for the outcome; that is, military participation. Based on the consistency scores, a cut-off point is determined for separating combinations that pass fuzzy-set sufficiency from those that do not. In my study, I elected a consistency threshold of 0.84. This meant that all configurations below Row 5 were excluded from the following minimization procedure performed by the software. I decided to exclude Row 6 because it would have lowered overall consistency but added only a single case (Norway) that held a low membership in the respective configuration (0.55). Hence, there was little inferential leverage to be gained by including this case.

The truth table is central to any QCA analysis. Even without the minimization procedure, the truth table provides comprehensive information concerning the structure of the data. As such, Table 9.5 tells us which conjunctions are filled by which empirical cases and the extent of their fuzzy-set membership. Given our theoretical expectations, we can also examine specific combinations and see whether or not these lead consistently towards the outcome.

Boolean minimization and solution terms

Based on the truth table algorithm and the consistency cut-off value specified by the researcher, the software can be used to derive three solution terms – complex, parsimonious and intermediate – that differ in the treatment of logical remainders. The *complex solution* provides a conservative estimate, because it does not make any assumptions beyond the empirical cases. As the name implies, this approach also tends to produce the lengthiest solution terms. In contrast, the *parsimonious solution* includes logical remainders but does not assess their plausibility. Although

Table 9.5 Truth table for 'military participation' in the Iraq War

Military power	*Parliamentary veto*	*Constitutional restrictions*	*Public support*	*Right executive*	*Military participation (outcome)*	*Consistency*	*N*	*Countries*
1	1	0	0	1	1	0.94	1	ITA (0.60)
1	0	0	0	1	1	0.93	2	USA (0.77), GBR (0.65)
0	0	0	0	1	1	0.87	5	AUS (0.76), ESP (0.66), NLD (0.60), PRT (0.60), POL (0.52)
0	1	0	0	1	1	0.84	4	DNK (0.84), SVK (0.60), SVN (0.58), EST (0.55)
0	1	0	0	0	1	0.84	6	LTU (0.73), BGR (0.72), ROU (0.72), HUN (0.69), CZE (0.64), LVA (0.62)
0	0	1	0	0	0	0.83	1	NOR (0.55)
1	0	0	0	0	0	0.77	1	FRA (0.68)
1	1	1	0	1	0	0.65	1	JPN (0.60)
0	1	1	0	1	0	0.58	1	FIN (0.60), AUT (0.51)
1	1	1	0	0	0	0.58	1	DEU (0.73)
0	0	0	0	0	0	0.54	4	NZL (0.80), GRC (0.78), CAN (0.76), BEL (0.71)
0	1	1	0	0	0	0.45	2	SWE (0.82), IRL (0.75)

Source: own table, based on Mello (2014: 172).

this leads to solution terms that are easier to interpret, the parsimonious solution should always be treated with care and contrasted with other solutions, because it could comprise implausible assumptions. Finally, the *intermediate solution* allows the researcher to designate how logical remainders are to be treated based on explicit expectations about the causal relationship; hence, it is positioned between the complex and the parsimonious solutions.

Table 9.6 shows the analytical results for war involvement in Iraq. The top rows display the previously identified necessary conditions. As expected from the analysis of necessity, all paths towards military participation contained the absence of constitutional restrictions (~C). The complex solution further entailed public opposition (~S), which is also implicated in the other solution terms but is not part of the minimized formulas. Measures of consistency and raw coverage are given for each solution term, whereas solution paths further specify raw coverage and unique coverage. The latter indicates 'how much' is explained *exclusively* by a respective path, whereas raw coverage also includes empirical overlap. For example, the parsimonious solution term includes two paths and has an overall consistency of 0.77 and coverage of 0.85; however, we can see that Path 1 has a consistency of 0.82 and a *unique coverage* of 0.28 (indicating how many cases this path can account for).

The solution terms show that two consistent pathways towards military participation exist. The first entails a right executive (E) and the absence of constitutional restrictions (~C), as indicated in Path 3. The second comprises the absence of

Table 9.6 Solution terms for 'military participation' in the Iraq War

	Conjunction	*Relation*	*Consistency*	*Raw coverage*	*Unique coverage*
Necessary condition					
	~C	←MP	0.94	0.64	–
	~S		0.97	0.50	–
Parsimonious solution term			0.77	0.85	–
Path 1	~C*E	+	0.82	0.69	0.28
Path 2	V*~C	→MP	0.75	0.57	0.17
Intermediate solution term			0.79	0.85	–
Path 3	~C*E	+	0.82	0.69	0.31
Path 4	~M*V~C	→MP	0.77	0.54	0.17
Complex solution term			0.80	0.84	–
Path 5	~C*~S*E	+	0.84	0.68	0.30
Path 6	~M*V~C*~S	→MP	0.78	0.54	0.17

Source: own table, based on Mello (2014: 173)

Note
[M] Military Power, [V] Parliamentary Veto, [C] Constitutional Restrictions, [S] Public Support, [E] Right Executive, [MP] Military Participation, [~] absence of a condition, [*] logical 'and', [+] logical 'or', [←] necessity, [→] sufficiency.

military power (~M) and constitutional restrictions (~C) with parliamentary veto rights (V), as shown in Path 4. This finding lent some support to the partisan argument and the expectation that small powers without constitutional restrictions had had incentives to become involved militarily in the Iraq War.

Visualization of results

To assess the validity of the analytical results and to relate them to individual cases, graphic means of representation can be helpful. For this purpose, I constructed an *x–y* plot that displayed each country's membership in the complex solution term in relation to its membership in the outcome. The plot showed that the complex solution was (almost) sufficient for military participation because a large majority of countries were placed above the main diagonal, which reflects the subset relationship. As defined above, a sufficient condition X is given whenever X resembles a *subset* of Y, meaning that all values for X are equal to or less than the values for Y. Hence, cases on or above the diagonal fulfil the subset criterion for a sufficient condition.

Figure 9.1 shows four groups of cases. Countries in the lower-left corner hold low membership values in outcome and solution and can thus be considered

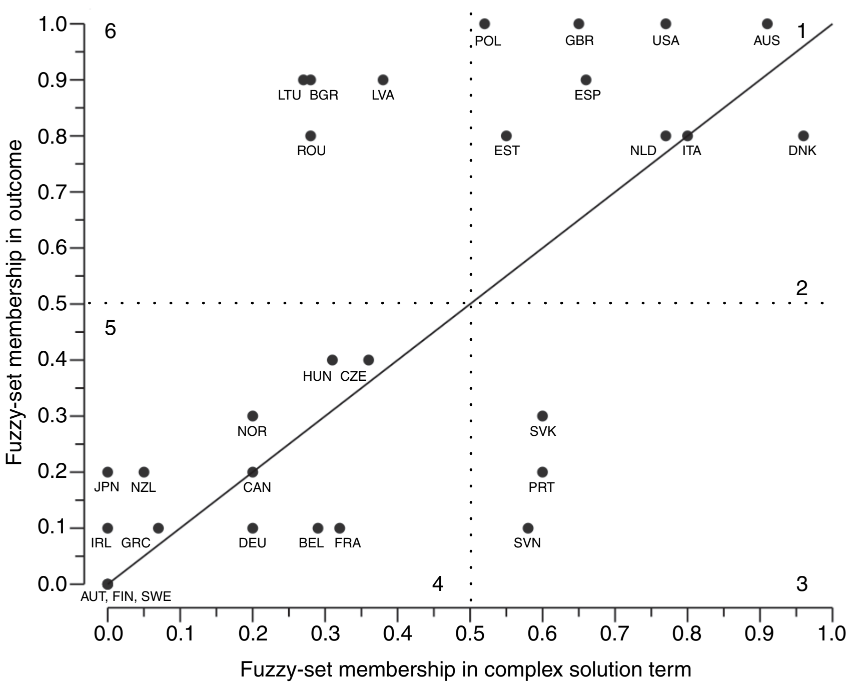

Figure 9.1 Military participation and solution term.

Source: own figure, based on Mello 2014: 174.

largely irrelevant for the analysis. In contrast, 12 out of 30 democracies hold membership in the solution term (Zones 1 to 3), eight of which can be considered typical cases (Zone 1). In turn, Zone 3 holds three deviant cases, as in countries with membership in the solution that do not show the expected outcome. In other words, based on their characteristics, one would have expected Portugal, Slovakia and Slovenia to contribute to the Iraq War beyond their actual involvement. Finally, Zone 4 includes countries that show the outcome but do not hold membership in the solution. This indicates that alternative explanations may better account for the pattern observed in these particular cases.

Depending on the specific aim of a research project, the next step could be the selection of cases for an in-depth study by means of process-tracing (see Chapter 8 by Andreas Kruck). Here, the *x–y* plot can be useful in identifying appropriate cases for further study (Schneider and Rohlfing 2013). For example, in Figure 9.1, we could select a case either from Zone 3 to explain why the country did not participate as expected or from Zone 6 to discuss alternative explanations for the observed participation that were not covered by our theoretical framework.

Interpretation of results

QCA solution terms tend to be complex and difficult to interpret. Hence, it is important to formulate specific theoretical expectations *before* the analysis and relate these to the results provided by the software. Rather than focusing solely on the analysis of the outcome, it is further recommended to also examine the *non-outcome*. That being said, for reasons of space I will solely highlight some selected findings for the analysis of the outcome of military participation (for details, see Mello 2014: 176–181).

First, the absence of constitutional restrictions was found to be a necessary condition for military participation and was also part of all sufficient conjunctions. This finding contradicted the argument presented in some previous studies that constitutional settings would not constrain decision-making regarding the use of force. Second, the analysis shed light on the relationship between partisanship and war involvement. As expected, left or right partisanship were *individually* neither necessary nor sufficient. Instead, it was confirmed that these constitute INUS conditions. A rightist government combined with the absence of constitutional restrictions was sufficient for involvement in the Iraq War. Countries with a high level of membership in this path included, among others, Australia, Spain and the United States. Finally, the 'parliamentary peace' hypothesis could not be confirmed. Earlier studies suggested that parliamentary veto rights should serve as an effective constraint against war involvement (Dieterich *et al*. 2015), especially when combined with widespread public opposition to the use of force (V*~S). Although this pattern was found empirically, it crossed with constitutional restrictions and was thus overdetermined with regard to explaining military non-participation. Moreover, countries such as Italy, Denmark, Bulgaria, and several others also held membership in (V*~S), but for them the expected mechanism failed to prevent military involvement.

Conclusion: strengths and limitations of QCA

QCA has gained recognition as a research approach that offers distinct advantages for comparative studies. Although many existing QCA applications take a *macro-comparative* perspective, there is nothing inherent in the set-theoretic approach that would prevent it from being used for the study of NSAs in the field of international security. Hence, this chapter should also be understood as a plea for the (wider) application of QCA in this specific area of research. To this effect, it has provided an outline of the core principles and terminology of QCA and complemented this methodological introduction with a step-by-step illustration of an empirical study.

As discussed in the theoretical section and shown in the empirical part of this chapter, QCA allows the researcher to take into account *causal complexity* – most importantly, the fact that different pathways can lead towards the same outcome and that a combination of conditions can be jointly necessary and/or sufficient for an outcome. Moreover, QCA offers a *systematic* and *rigorous comparative approach*. Yet it gives researchers *flexibility*, because crisp and fuzzy sets can be calibrated on the basis of qualitative and quantitative sources of data, depending on the particular research aim and the type of information required to operationalize one's theoretical framework.

Despite these strengths, it should be noted that QCA also has several limitations.[6] First, a researcher interested in using QCA would need to 'buy into' the set-theoretic logic, because it is the central methodological assumption of the approach. Certainly, it would make no sense to test probabilistic hypotheses within a set-theoretic framework. Likewise, if the language of necessary and sufficient causation does not fit with the research aim of a given study, then QCA should simply not be used. Second, the truth table analysis itself is a static approach. Hence, it is difficult to incorporate assumptions about sequence and timing in a QCA framework because the analysis treats all conditions the same way. There are variants of QCA that try to circumvent this limitation and include 'time' as a factor; but as of now, these still come with substantial drawbacks (see Schneider and Wagemann, 2012: 263–274). Finally, in order for QCA to 'get off the ground' and work properly, a certain number of cases are required, because it gets increasingly difficult to conduct the truth table analysis if there are not enough observations. Although some studies have involved as few as nine cases, this numerical restriction might be the biggest obstacle to using QCA for some research projects on NSAs. Nonetheless, when the requirements of a set-theoretic approach are met, the application of QCA can certainly be a rewarding strategy for research projects on NSAs in international security.

Notes

1 For a demonstration of the effects of different calibration techniques and their application in QCA, see Ragin (2008: 85–105) and Schneider and Wagemann (2012: 32–41).
2 The mathematical formulas behind these measures are introduced and discussed in Ragin (2006).

3 For an elaborate discussion of these strategies, see Schneider and Wagemann (2012: Chapter 6).
4 On various ways to use QCA, see Berg-Schlosser *et al*. (2009: 15–16).
5 For a comparison of the various software packages, see Schneider and Wagemann (2012: 283).
6 For a comprehensive discussion of the strengths and limitations of QCA, see the symposia published in the APSA Newsletter *Qualitative Methods*, 2004 (2)2, in *Studies in Comparative International Development*, Spring 2005 (40)1, *Political Research Quarterly* 2013 (66)1 and *Sociological Methodology* 2014 (44)1. A detailed reply to some of the critiques can be found in Meur *et al*. (2009).

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