Chapter 8

QCA Variants

Mello, Patrick A. (2021) *Qualitative Comparative Analysis: An Introduction to Research Design and Application*, Washington, DC: Georgetown University Press, Chapter 8.

It is the set-theoretic foundation from which all other features of this family of methods derive.

Carsten Schneider and Claudius Wagemann [1]

This book has focused on the crisp-set and fuzzy-set variants of QCA. These are the most popular and widely used variants of the method, as was shown in the cross-discipline survey of empirical QCA applications (Chapter 2). Yet, QCA comprises a whole family of approaches under the big tent of *set-theoretic methods*, as indicated in the opening quote by Carsten Schneider and Claudius Wagemann (see also Rihoux and Ragin 2009).[2] This chapter introduces four major variants and approaches of QCA, to complement the foregoing discussion and to give new users an idea about the respective strengths and limitations. These are multi-value QCA, temporal QCA, fuzzy set ideal type analysis, and two-step QCA. For some of these, a vast literature has developed. Rather than trying to summarize all of the contributions that have been made over the years, my aim for this chapter is to provide concise introductions, so that readers can make an informed choice about what to pursue for their specific research aims. The chapter concludes with a brief look into some additional variants and alternatives to QCA, such as Necessary Condition Analysis (NCA), MDSO-MSDO designs, and Coincidence Analysis (CNA).

Multi-Value QCA

When designing QCA studies, a recurrent challenge with crisp and fuzzy sets is that the former require the data to be dichotomized and the latter call for the definition of a cross-over between being *rather inside* as opposed to *rather outside* the target set. Hence, despite their gradations, fuzzy sets effectively entail only two qualitative states. These limitations spurred the development of multi-value QCA (mvQCA), pioneered by Lasse Cronqvist, who also developed the accompanying TOSMANA software (Cronqvist 2004; Cronqvist and Berg-Schlosser 2009).[3]

As the name implies, the idea behind multi-value QCA is that conditions are allowed to take on several different values. This means that *categorical data* with three or more different values can be used in the analysis. This kind of data is also referred to as *polychotomous*, as in being divided into many classes or parts. The advantage of mvQCA is that polychotomous data can be used more or less *as it is*, without having to introduce a dichotomous threshold for crisp sets or empirical anchors for fuzzy-set calibration.

For example, imagine we wanted to study the relationship between individuals' employment status and their life satisfaction. Rather than distinguishing solely between *employed* and *unemployed*, we may also want to include a separate category for *employed at minimum wage*, because we expect this group of people to show different characteristics from those who are working for a regular salary above the minimum wage. With multi-value QCA, we can include a condition with different values in our study: *unemployed*, *employed at minimum wage*, and *employed above minimum wage*. Of course, one could also introduce two crisp-set conditions to capture these differences. Apart from creating additional conditions, the downside of such an approach would be that it can easily create impossible combinations like *unemployed at minimum wage* (see the discussion of untenable assumptions in Chapter 7).

While multi-value QCA follows the same protocol for the analysis of necessary conditions and the minimization of the truth table, there are three important differences (Cronqvist and Berg-Schlosser 2009). First, the *notation* is different, because for each condition, the value or *level* has to be specified. By convention, this is done in curly brackets: In our example, *employment*{2} refers to employment above minimum wage, whereas *employment*{1} indicates employment at minimum wage, and *employment*{0} reflects unemployment.[4]

The second difference relates to the size of the *truth table*. Because multi-value conditions exist at different levels, each of them can logically combine with other conditions at their respective levels. This means that the truth table *grows exponentially* with each multi-value condition. To calculate the total number of possible combinations we thus need to multiply the *number of levels* for each condition. For example, in a study with four conditions, three of which have three levels each and where the third condition is a crisp set with two possible levels, the calculation of the size of the truth table yields 54 rows:

$$3_A \times 3_B \times 3_C \times 2_D = 54 \text{ rows}$$

By contrast, if the same study had used only crisp or fuzzy-set conditions, the truth table would have consisted of only 16 rows:

$$2^{(A,\,B,\,C,\,D)} = 2^4 = 16 \text{ rows}$$

The final difference relates to *Boolean minimization* and the polychotomous nature of the conditions, which means that multi-value QCA requires an adapted version of the Boolean minimization rule (Ragin 1987, 93), introduced in Chapter 7:

> "A condition can be considered irrelevant if a number of logical expressions differ in only this condition and produce the same outcome, *and if all possible values of this condition are included in these logical expressions*" (Cronqvist and Berg-Schlosser 2009, 74; emphasis added).

How does this affect the minimization procedure? To illustrate the process, let us take an example with a crisp-set condition C, a multi-level condition M (with three levels), and the outcome O. Imagine that the truth table contains three rows that consistently lead towards the outcome. All of these contain the presence of the crisp-set condition C, combined with M at each of the possible levels.

(1) $C\{1\}{\cdot}M\{0\} + C\{1\}{\cdot}M\{1\} + C\{1\}{\cdot}M\{2\} \rightarrow O$

Under these circumstances, we can consider M *irrelevant*, because whenever C is present it leads to the outcome O, irrespective of M's level (and all three levels are covered). Hence, we can minimize the primitive expressions from line (1) to reach the following simpler statement in line (2):

(2) $C\{1\} \rightarrow O$

This simple example demonstrates that multi-value conditions *increase the requirements* for Boolean minimization. To erase a multi-value condition from a complex expression, we need empirical cases for each level and all of them have to share the remaining configuration and the outcome.

Multi-Value QCA: An Applied Example

How does mvQCA look like in practice? To illustrate some of the differences and similarities, let us look at a published study. In his article on judicial independence, Pablo Castillo Ortiz

(2017) examines the conditions under which Councils of the Judiciary are perceived by judges as impediments to their judicial independence (see Box 8.1 at the end of this section). The article draws on a cross-national survey conducted by the European Network of Councils of the Judiciary (ENCJ), which informs several of the conditions used. The study includes 17 cases, representing different European jurisdictions. The four explanatory conditions include three crisp sets and one multi-value condition, whereas the outcome is also multi-value (the calibration of the multi-value condition and outcome are summarized in Table 8.1).

The outcome *disrespectful Council* is a multi-value condition based on the share of respondents' who indicate that their judicial independence has not been respected by judicial councils. For cases where this exceeds 9.5%, a level of 2 is assigned, whereas a level of 1 is given for a share between 4.5% and 9.5%, and a share of less than 4.5% results in a level of 0. The multi-level condition *appointment* reflects whether the nomination procedure for the Judicial Council is controlled by the judiciary itself without any political influence (level 0), whether the procedure is controlled by political actors (level 2), or whether the appointment procedure shows traces of both and can thus be considered a hybrid (level 1).

Table 8.1 Multi-Value Condition and Outcome

Multi-value condition/outcome (*selection*)	Multi-value operationalization	Sources
Outcome: High perception of disrespect for judicial independence	{2} = $X_i > 9.5\%$ {1} = $4.5\% > Xi > 9.5\%$ {0} = $Xi < 4.5\%$	ENCJ questionnaire, share of respondents who indicated that their independence as judges had been not respected by the Council of the Judiciary
Condition: Nature of the appointment procedure for members of the Councils of the Judiciary	{2} = Primarily political {1} = Hybrid {0} = Primarily judicial or apolitical	EU Justice Scoreboard and ENCJ website (Factsheets on member states), secondary literature

Data source: Castillo Ortiz (2017).

As mentioned above, the analytical protocol for mvQCA follows the standard procedure described in Chapter 7. Yet, because the study by Castillo Ortiz (2017) contains a multi-level outcome, each of the levels has to be analyzed on its own. Hence, the article contains separate analyses for a *high perception of disrespect* (outcome {2}), a *low perception of disrespect* (outcome {0}), and a *moderate perception of disrespect* (outcome {1}).

Table 8.2 shows the truth table for the outcome high perception of disrespect (OUT). For illustrative purposes, the table also contains logical remainder rows and cases' outcome values are given in curly brackets in the right-hand column. We can see how multi-level conditions further differentiate the truth table: Bulgaria and Portugal in the first two rows have nearly identical configurations, and both show the same level in the outcome. But since the countries differ in the multi-value condition *appointment*, they end up on different truth table rows.

With one multi-value condition and three crisp-set conditions, the number of truth table rows equals 3 × 2 × 2 × 2 = 24 rows. Eleven of these are filled with empirical cases, while thirteen are logical remainders. By comparison, if the study had used solely crisp and/or fuzzy sets, then there would have been only 16 rows (2^4) and nine of these would have been filled with empirical cases. Here, the difference is rather small, because there is only one multi-value condition. But the calculation illustrates the exponential increase of limited diversity that is at stake when multi-value conditions are introduced.

Table 8.2 Truth Table with Multi-Value Conditions

A	P	C	T	OUT	*N*	Consistency	PRI	Cases {outcome value}
0	1	1	1	1	1	1.00	1.00	BGR {2}
0	1	1	2	1	1	1.00	1.00	PRT {2}
1	1	0	0	1	1	1.00	1.00	ITA {2}
1	1	0	2	1	1	1.00	1.00	ESP{2}
1	0	0	0	0	3	0.33	0.33	LVA {1}, GBR-NIR {2}, GBR-SCO {0}
0	0	0	0	0	3	0.00	0.00	IRL {0}, POL {0}, GBR-ENG {0}
0	0	0	1	0	2	0.00	0.00	BEL {0}, DNK {0}
0	1	0	1	0	2	0.00	0.00	ROU {1}, SVN {1}
0	0	0	2	0	1	0.00	0.00	NLD {0}
0	0	1	1	0	1	0.00	0.00	SVK {1}
0	1	1	0	0	1	0.00	0.00	LTU {1}
0	0	1	0	?	0	–	–	–
0	0	1	2	?	0	–	–	–
0	1	0	0	?	0	–	–	–
0	1	0	2	?	0	–	–	–
1	0	0	1	?	0	–	–	–
1	0	0	2	?	0	–	–	–
1	0	1	0	?	0	–	–	–
1	0	1	1	?	0	–	–	–
1	0	1	2	?	0	–	–	–
1	1	0	1	?	0	–	–	–
1	1	1	0	?	0	–	–	–
1	1	1	1	?	0	–	–	–
1	1	1	2	?	0	–	–	–

A: Association, P: Powers, C: Corruption, T: Appointment,
Data source: Castillo Ortiz (2017).

Finally, let us have a look at some of the study's results, summarized in Table 8.3. The table displays the *intermediate solution*, based on directional expectations where the presence of a crisp-set condition and level 2 of the multi-level condition are associated with the outcome, as reported in Castillo Ortiz (2017, 327). This yields four paths, the first two of which are populated by Spain and Italy, which share the expression A · P, but differ in their appointment procedure (multi-level condition T). Similarly, Bulgaria and Portugal both show the conjunction P · C but differ in their values for T. Apart from notational differences, the mvQCA results can be reported in the same fashion as for other QCA studies. Yet, because the levels must be included, the notation becomes more complex and less intuitive to read.

Table 8.3 Multi-Value QCA: Intermediate Solution Term

Path		Relation	Consis-tency	PRI	Raw coverage	Unique coverage	Cases
Intermediate solution			1.00	1.00	0.80	–	–
1	A{1}·P{1}·T{2}	+	1.00	1.00	0.20	0.20	Spain
2	A{1}·P{1}·T{0}	+	1.00	1.00	0.20	0.20	Italy
3	P{1}·C{1}·T{1}	+	1.00	1.00	0.20	0.20	Bulgaria
4	P{1}·C{1}·T{2}	⟶ OUT	1.00	1.00	0.20	0.20	Portugal

A: Association, P: Powers, C: Corruption, T: Appointment, directional expectations: A {1}, P {1}, C {1}, T {2}. *Data source*: Castillo Ortiz (2017).

In sum, multi-value QCA presents a viable alternative for studies where conditions cannot be adequately transformed into crisp sets or where researchers want to keep a distinction between more than two qualitative levels in a condition that cannot be expressed with fuzzy sets. Moreover, given the integration of mvQCA in the QCA package for R (Duşa 2019) and the existence of the stand-alone software TOSMANA (Cronqvist 2019), it is straightforward for users to implement the multi-value variant, also because the analytical procedure closely resembles a standard QCA routine. Previously, it was not possible to have a multi-value outcome (Cronqvist and Berg-Schlosser 2009, 84), but this limitation has been resolved with recent software developments (Duşa 2019) and shown in the example above (Castillo Ortiz 2017).

That being said, the *increased complexity* of mvQCA presents a challenge that is not easily overcome. The truth table becomes substantially larger with every multi-value condition. For this reason, most mvQCA applications limit the number of actual multi-value conditions and use mostly crisp-set conditions. This is in line with recommendations on multi-value QCA (Cronqvist and Berg-Schlosser 2009), namely to use a *maximum of two to three multi-value conditions*, irrespective of the overall number of conditions included in a study. We can see this in many published applications of mvQCA, for example in the studies by Feliciano de Sá Guimarães and Maria Hermínia Tavares de Almeida (2017), Tim Haesebrouck (2018), and Giulia Mariani (2020), apart from the study by Pablo Castillo Ortiz (2017) discussed above and introduced by the author in Box 8.1. All of these articles include just one or two conditions that take on multiple values and use crisp sets for the remaining conditions (see also the review by Alrik Thiem 2013).

The challenges and critical points about multi-value QCA are reflected in a debate about the relative merits of this approach. Critics point out that the logic of polychotomous conditions is difficult to reconcile with set theory because membership in crisp or fuzzy sets "is essentially different" from membership in multi-value conditions (Vink and van Vliet 2009; 2013, 213). As Schneider and Wagemann (2012, 259) argue, "If there is no non-membership, it suggests that multi-value variables are indeed not sets". Moreover, mvQCA amplifies limited diversity and this brings along the problem of *untenable assumptions* once logical remainders are used to minimize the truth table, especially if the standard parsimonious solution is used (Schneider and Wagemann 2012, 261). This problem is magnified by the recommendation that in mvQCA "logical remainders have to be included in larger data sets to obtain meaningful results" (Cronqvist and Berg-Schlosser 2009, 76). Supporters of mvQCA have responded by showing the value added in using mvQCA rather than crisp- or fuzzy-set variants, pointing to examples of published research (Haesebrouck 2016) and arguing that some of the criticism against mvQCA is misguided (Thiem 2013).

To conclude, the decision whether to use multi-value QCA should be primarily based on the target concept. If this cannot suitably be expressed as a crisp or fuzzy set, then one should consider mvQCA. In any event, multiple-value conditions should be used sparingly and, as always, solution terms must be scrutinized for their simplifying assumptions (see Chapter 7). While this applies to all QCA applications, mvQCA is particularly prone to large numbers of logical remainders, due to the further growth of the truth table once multi-value conditions are introduced.

Box 8.1 Multi-Value QCA: Judicial Independence (Castillo-Ortiz 2017)

Using Multi-Value QCA to Study Councils of the Judiciary and Judges' Perceptions of Respect to their Independence

By Pablo Castillo-Ortiz (*School of Law, University of Sheffield*)

The multi-value QCA study (Castillo Ortiz 2017) is part of my research line about higher judicial actors in Europe, in which I have explored mainly Constitutional Courts and Judicial Councils. My academic work about these institutions is at the cross-roads of law and politics, and it has focused on aspects such as the causes of the design of these institutions, their process of decision-making, and their effect on public perceptions of the judiciary as a whole.

In my academic work, I have often used Qualitative Comparative Analysis as my main method of research. In fact, QCA methods have seldom been used to tackle law-related research inquiries. Although there are some precedents in the area of legal and judicial studies, the use of configurational methods in the field of legal research is still rather limited. By way of hypothesis, my intuition is that this might simply be the result of the predominance of doctrinal and theoretical pieces in the legal field, to the detriment of empirical research methods in general. This is regrettable, as QCA has an enormous potential to understand legal dynamics and phenomena.

In this piece in particular, I decided to use QCA because I wanted to understand the interactions between explanatory conditions in the production of outcomes. From the outset, I hypothesized that the phenomena that I wanted to explore – judges' perceptions of disrespect to their independence by Judicial Councils – had a configurational causation. This was based on my preliminary knowledge of certain cases that I had studied beforehand, notably the Spanish case. In Spain, two interesting circumstances converged: The Judicial Council is powerful, and the system of appointment of its members had been criticized as too political. QCA allowed me to understand interactions between explanatory conditions like these in a systematic and rigorous way. In this paper, the multi-value version of QCA was used, as there were conditions that were multichotomous in nature; for instance, the system of appointment of members of Judicial Councils, which I classified into political, apolitical or hybrid.

The evidence offered by the paper is preliminary, and future research will be necessary to confirm the results, especially with analyses at the level of individual judges and with more quality data. However, I believe that the findings of the paper are interesting and that they tell something relevant about Judicial Councils. In particular, the paper shows that certain institutional designs of Judicial Councils – for instance, powerful Judicial Councils controlled by political actors or interest groups – can have a negative impact on the self-perception of independence of judges, so such designs might have to be re-thought or simply avoided. Thus, QCA has also a strong potential for evidence-based assessment and design of legal-political institutions.

Temporal QCA

One particular limitation of QCA is that it is a *static* approach, as noted in Chapter 2 on research design. This means that all of the conditions in a QCA study are treated in the same way and the analysis does not consider the timing or sequence in which the included conditions appeared. For many research aims this is fine. However, for some topics *timing* is crucial and it may even be the most important part of the analysis (Büthe 2002; Sewell 1996).

For example, most scholars on democratization would agree that a successful democratic transition requires a minimum level of peace and stability, functioning state structures, free and fair elections, and an independent judiciary. Yet, there is disagreement about which of these factors should come first. Should democratic elections be held as early as possible or should these be preceded by the creation of political institutions? With a standard QCA analysis, these factors would only be compared as static conditions, which would allow us neither to assess when something occurred (*timing*) nor which condition preceded another condition (*sequence*).

That said, there are suitable approaches how timing and sequence can be incorporated in the *research design* of a QCA study. Clearly, the most forthright way is by including observations (cases) at different points in time. For example, instead of looking at a single case per country, we could include separate cases for each government cabinet, or we could use pre-defined periods of time as cases (as in yearly observations, months, or days). In fact, many QCA applications have used such approaches to *indirectly incorporate time* in their *casing* (e.g., Fagerholm 2014; Mello 2020; Vis 2011; Wurster and Hagemann 2018).

Another option is to address timing and sequence in the *conceptualization and calibration* of conditions. In that vein, instead of calibrating a set "economic strength" on the basis of gross domestic product at a given point in time (based on yearly statistics), we could conceptualize "economic growth" from one point in time to another. This resulting percentages in growth could serve as a basis for the calibration procedure. Finally, time could also be taken into account by assigning *time-sensitive membership scores* to cases. As such, we might attribute different scores to cases based on whether an event happened sooner or later. This is done in Mello (2012, 433), where the outcome "military participation" in the Iraq War takes into account the *time of deployment*, assigning lower scores to later events, because the legal status of the military operation changed over time and thus arguably affected political calculations. Another way to address time is by *reconstructing the historical sequence* after the QCA analysis, as done by Stefan Lindemann and Andreas Wimmer (2018) in their analysis of conflict escalation. Notably, the authors find that across the 21 cases covered by their solution, "there is only one temporal sequence to ethnic war" (2018, 315). These are examples of the many feasible ways how timing and sequence can be incorporated at the research design stage.

Apart from these approaches to acknowledge timing and sequence through research design, some inroads have been made to formally incorporate time in the analytical procedure of QCA (Caren and Panofsky 2005; García-Castro and Ariño 2016; Hino 2009; Pagliarin and Gerrits 2020; Ragin and Strand 2008). The first attempt was made by Neal Caren and Aaron Panofsky (2005), who developed temporal QCA (tQCA) as an approach to manually combine QCA with the analysis of sequences. This was taken up by Charles Ragin and Sarah Strand (2008), who showed how tQCA could be implemented in the existing software, but who also pointed out pitfalls in the analytical procedure of tQCA. Notably, Airo Hino (2009) developed a related approach which he termed time-series QCA (TS/QCA).

Essentially, tQCA introduces another logical operator to indicate whether a condition came before another condition (as in *A before B* or *B before A*). Cases are coded accordingly: they can receive a score of 1 (if A happened before B), a score of 0 (if both conditions are present but A did not come before B), or they receive a dash sign "—" to indicate *don't care* cases. These are cases where either of the two conditions is not present and where it is thus not possible to say that one preceded the other.

To illustrate the procedure, let us take a simple example: with three conditions A, B, C, there are six logically possible sequences how these conditions can appear in empirical data, summarized in Table 8.4. Notably, this is based on the assumption that sequences can only comprise the *presence* of conditions, understood as their occurrence (*A happened before B, which happened before C*, and so forth). Otherwise, there would be many more combinations of conditions.

Table 8.4 Possible Sequences with Three Conditions

Sequence	1st	2nd	3rd
1	A	B	C
2	A	C	B
3	B	A	C
4	C	A	B
5	B	C	A
6	C	B	A

These possible sequences have to be added to the truth table. To take our example, this would mean that there is not just a single row with the configuration where all three conditions are present (A·B·C), but *six rows* with different sequences of these three conditions. Based on this logic, we can see that the truth table grows explosively with tQCA. This is the reason why tQCA should only be used with very low numbers of conditions. Again, this is a trade-off: We can either focus on two or three conditions and also explore their sequence (if that is imperative for our research aim), or we can include more conditions for a more comprehensive account, but then we cannot include timing in a formalized way as through tQCA.

Questions of temporality remain an intriguing area of research. Along those lines, Roberto García-Castro and Miguel Ariño (2016) developed diagnostic tools for the set-theoretic analysis of panel data with cross-sectional observations. Recently, Sofia Pagliarin and Lasse Gerrits (2020) proposed Trajectory-Based QCA (TJ-QCA), to account for within-case time variation, building on the approach put forth by Hino (2009). For further discussions of timing and sequence, see De Meur et al. (2009, 161-63), Schneider and Wagemann (2012, 269-73), Duşa (2019, 209-13), and Kahwati and Kane (2020, 189-95). For a discussion of temporality with a focus on policy processes in comparative public policy, see Fischer and Maggetti (2017).

Two-Step QCA

One of the persistent challenges of comparative research is *limited diversity*. In the set-theoretic context this means that the number of logically possible configurations exceeds the number of empirical cases (see Chapter 2). This problem increases with each condition that is added to the analysis, which is one reason why users should not use more than a moderate number of conditions for most types of QCA applications. The other reason is that solutions tend to become increasingly complex and difficult to interpret with more conditions.

This was the starting point for Schneider and Wagemann (2006) to suggest a *two-step approach* to QCA. Distinguishing between *remote* and *proximate* conditions, this approach splits up the analysis into separate truth table procedures. The first stage entails running an analysis solely with remote conditions. These can be conceived of as "context" or "structure" conditions that are expected to influence the outcome, but only in an *indirect way* through actors, institutions, organizations, and the like. The latter are examples for proximate conditions, which can be regarded as factors that are *causally closer* to the outcome, and which can have an immediate impact on the phenomenon of interest. For instance, these could be politicians who vote on a motion, bureaucrats who formulate a directive, institutions in charge of implementing policies, or judges deciding on legal cases.

During the first step of two-step QCA, an analysis is conducted with all of the remote conditions, to identify "outcome-enabling conditions" (Schneider and Wagemann 2006, 761). Because this part of the analysis is intentionally "under-specified", a lower consistency threshold is deemed acceptable (Schneider and Wagemann 2012, 254). For the second step, the solution paths from the first step are placed in QCA analyses together with all of the proximate conditions. In practice, this means that new conditions are created, one for each of the solution paths from the first step, and these are inserted into separate truth table procedures during the second step.[5]

Effectively, two-step QCA thus reduces the number of conditions that are used in a single analysis by splitting up the procedure and eliminating some of the remote conditions after the first step, which reduces limited diversity. It also allows a comparison between different outcome-enabling contexts. Another reason why two-step QCA has been well received lies in the adaptability of the concept of remote and proximate conditions. These resonate with many social science theories and can thus be easily applied to research designs across academic fields.

Two-step applications have examined such diverse topics as women in political leadership positions (Inguanzo 2020), regulatory agencies in policy-making (Maggetti 2009), democratic regression and breakdown (Tomini and Wagemann 2018), policies addressing deforestation (Brockhaus et al. 2017; Korhonen-Kurki et al. 2014),[6] equal pay laws and their institutionalization (Laux 2016), contributions to UN peacekeeping operations (Haesebrouck

2015), large dam projects and resettlements (Kirchherr et al. 2019), and e-mobility policies (Held and Gerrits 2019). In the following section, we will look into the study by Tomini and Wagemann (2018) to illustrate the two-step research process. For another example, see Box 8.2 at the end of this section, where Maria Brockhaus, Jenniver Sehring, Kaisa Korhonen-Kurki, and Monica Di Gregorio share some insights on the research project behind their QCA studies (Brockhaus et al. 2017; Korhonen-Kurki et al. 2014), and why they chose two-step QCA for these.

Two-Step QCA: An Applied Example

To illustrate how two-step QCA works in practice, let us have a look at an example. Luca Tomini and Claudius Wagemann (2018) apply the two-step approach to explain under which conditions *democratic breakdown* occurs, which is understood as the transformation of democracies into hybrid or authoritarian regimes. Their analysis entails 59 cases of democratic regression, as in countries that experienced "a negative trend in democratic performance" (2018, 695). Tomini and Wagemann include a total of nine conditions, which are split into six remote conditions and three proximate conditions. The *remote conditions* are (1) economic development, (2) economic inequality, (3) the fragmentation of the party system, (4) the duration of democracy, (5) ethnolinguistic fractionalization, and (6) the external context, which relates to the political regimes of neighboring countries. The *proximate conditions* are (7) concentration of executive power, (8) the volatility of the party system, and (9) social instability. As we can see, these conditions cover a wide range of economic, political, and social aspects that can be expected to impact upon democratic breakdown. However, if all of these were used in the same analysis, this would yield a truth table with 512 rows (2^9), an overwhelming majority of which would be logical remainders.

Here, the two-step approach helps to keep the number of conditions manageable, by dividing the analysis into two parts. During the first step, the six remote conditions are analyzed on their own, the results of which are summarized in Table 8.5. We can see that four of the six remote conditions appear in the solution, where they constitute three distinct paths towards the outcome. This is a *preliminary* solution that merely serves to establish the context conditions to be used in the second step. This is also why the low consistency of 0.656 is acceptable at this stage. For the second step of the analysis, Tomini and Wagemann (2018) create conditions for each of the three paths from Table 8.5 and use them as conditions to complement the three proximate conditions.[7] The results of the second step are shown in Table 8.6. We can see that the solution now reaches solid consistency and coverage scores. Effectively, the four paths occur under two different contexts (~DEVELO · ETHNOF for the first three paths and INEQUA for the last).

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Table 8.5 Two-Step QCA: Analysis of Remote Conditions

Two-step analysis (first step)	Paths		
	1	2	3
Remote conditions			
Economic development		⊗	●
Economic inequality	●		
Party system			
Duration of democracy			
Ethnolinguistic fractionalization		●	
External context			⊗
Consistency	0.77	0.65	0.77
Raw Coverage	0.67	0.75	0.25
Unique Coverage	0.10	0.23	0.02
Solution Consistency		0.66	
Solution Coverage		0.92	

Data source: Tomini and Wagemann (2018); black circles indicate the presence of a condition, crossed-out circles its absence.

Table 8.6 Two-Step QCA: Analysis of Remote & Proximate Conditions

Two-step analysis (second step)	Paths			
	1	2	3	4
Remote conditions				
Economic development	⊗	⊗	⊗	
Economic inequality				●
Ethnolinguistic fractionalization	●	●	●	
Proximate conditions				
Concentration of executive power	●		●	●
Volatility of the party system	●	●		
Social instability		●	●	●
Consistency	0.88	0.86	0.82	0.88
Raw coverage	0.45	0.37	0.46	0.49
Unique coverage	0.14	0.05	0.06	0.13
Covered cases	BO2; BR; DO1; GM1; MR1; NG; PE; PH2; SE; VE2	BO1, 2; BR; DO1; EC2; ML2; PG1; PE	BO2; BR; CO2; DO1; IN1, 3; MW; PG2; PE; PH1; TH; VE1	AR2; BO2; BR; CO2; DO1; LS; MW; MX; PG2; TR
Solution consistency		0.83		
Solution coverage		0.79		

Data source: Tomini and Wagemann (2018); black circles indicate the presence of a condition, crossed-out circles its absence.

In sum, the two-step approach addresses the central problem of having too many conditions and logical remainders and thereby effectively "reduces complexity", as aimed for by Schneider and Wagemann (2006; 2012). A positive side-effect is that the conceptual distinction between remote and proximate conditions resonates with various social science theories. Hence, many researchers should find it easy to translate their theoretical frameworks into two-step designs.

However, it should be noted that the two-step approach also entails some downsides. While the sequential analysis reduces the number of conditions that are used in a single truth table analysis, it also *increases* complexity because it leads to more truth tables and thus more solution terms, which poses a challenge for the substantive interpretation and the effective communication of QCA results. For example, if the first step yields three outcome-enabling contexts, then that means that three additional truth table procedures have to be run. If each of these also yield three solution paths, then a total of nine paths would have to be discussed and interpreted. For a journal publication, this is hardly feasible unless results are picked out selectively – which might provoke criticism due to the opacity of the process.

This point still applies, even when the solution paths from the first step are all inserted into a single truth table in the second step, as done by Tomini and Wagemann (2018) in the example discussed above. Moreover, while the concept of remote and proximate conditions has theoretical resonance, it appears that empirical applications do not always provide the necessary theoretical *reasoning* why some conditions are regarded as remote and others are seen as proximate. But without a well-grounded justification for this distinction, there will be many "moving parts" in a two-step study, since another setup and sequence in the conditions might yield different results. Here, the burden of proof is upon the researcher to justify that the distinction is plausible and required – as opposed to a more concise study with fewer conditions in a single truth table analysis (see Chapter 2 on approaches to condition selection).

Recently, Schneider (2019) has re-evaluated the two-step approach and, acknowledging weaknesses in the original procedure, suggested a change in the analytical protocol to focus on *necessary conditions* during the first stage of the analysis. Essentially, the revised first step would be about finding "necessary contexts" for the sufficient terms to be identified in the second step (Schneider 2019, 1117). In a response to Schneider's suggestions for reformulating the two-step approach, Tim Haesebrouck (2019) proposed an "alternative update" to improve the standard two-step protocol. Among others, this entails a new measure for "cumulative coverage" (Haesebrouck 2019, 2766). It remains to be seen whether users will adopt the suggested changes or continue using the original protocol for two-step QCA, but those interested in the two-step approach are advised to take these proposals into account when designing their QCA study.

Mello, Patrick A. (2021) *Qualitative Comparative Analysis: An Introduction to Research Design and Application,* Washington, DC: Georgetown University Press, Chapter 8.

Box 8.2 Two-Step QCA: Policies on Deforestation (Brockhaus et al. 2017)

Using Two-Step QCA to Explain (the Lack of) Transformational Policy Change for REDD+

By Maria Brockhaus (*University of Helsinki*), Jenniver Sehring (*IHE Delft*), Kaisa Korhonen-Kurki (*University of Helsinki*), and Monica Di Gregorio (*University of Leeds*)

Deforestation in the tropics is one of the most persistent environmental, social and economic problems of our times, embedded in complex domestic and international politics, economics and power relations. In the early 2000s a global mechanism to reduce emissions through avoided deforestation and forest degradation and other activities (called REDD+) was introduced under the UN Framework Convention on Climate Change (UNFCCC). Shortly after, we had the opportunity (the funding, and access to a widespread network of fellow researchers in the tropics working for decades on the issue of deforestation), to investigate the question of what enables (or hinders) policy change to effectively halt deforestation.

As part of a global research effort on REDD+ led by the Centre of International Forest Research (CIFOR), we designed a comparative analysis of 15 countries, through case studies and analysis of institutions, discourses, policy networks, and policy documents (Brockhaus et al. 2017; Korhonen-Kurki et al. 2014). We chose QCA, because of its potential to deliver rigorous analysis to inform policy and practice on the expected complex and diverse pathways to achieve carbon-effective, cost-efficient, and equitable REDD+ policy design, implementation and outcomes.

Country experts played a key role in the identification, selection, and assessment of factors to be included as remote and proximate conditions for our two-step QCA. They made the first round of assessment of conditions for their case and after that, all the assessments were discussed and compared in a joint workshop. Through this, country experts could set their case knowledge in relation to other cases while project coordinators and researchers at the global level could strengthen their overview across the cases. We found this particularly important to ensure a joint understanding of the indicators and thresholds for each condition and consistency in the assessment (there were more than 60 country experts involved). Data collection and assessment was conducted in 2012, 2014, 2016, with a further round in progress.

One of the benefits for us as researchers was that QCA helped us structure our data and engage with case specifics without losing track of theory. The two-step QCA reflects our theoretical assumptions about a wider enabling institutional environment (*remote conditions*), and the factors mostly related to the actors in the policy arena (*proximate conditions*), which are closer to the outcome and less stable over time.

One of the biggest challenges for our QCA analysis was the lack of stability and the dynamics in the emerging REDD+ policy domain, which made it hard to measure the outcome consistently with the same indicators. Ideally, the outcome would have been measured in reduced emissions in tCO_2 from deforestation per country, but our analysis was too early for measurable results of REDD+ at a national scale. We solved this by using a *process-oriented outcome*, which required a careful definition of the assessment criteria to avoid overlap with the conditions supposed to explain presence or absence of our outcome. In order to reflect the developments in the policy arena, we increased the threshold for a positive assessment in the second and third round. We also included other conditions in the analysis based on new insights and discussions. While this solved issues with the individual analysis in each year, it makes comparison over the three rounds of data collections challenging.

Another challenge we faced was to explain the application of QCA in our publications and presentations, so that it is was accessible enough for readers (and reviewers) interested in REDD+ and not familiar with the method, while being detailed enough for those who are – starting with the specific *terminology*. As a result, we often ended up with contradicting reviews – asking for either more or less case material, or more or less methodical reflections. We would have wished to learn more from and with reviewers on the method, in particular the two-step application, and our thematic area, but the combination of both is hard to find. Our advice would be to think carefully about reviewers to suggest who can provide you with a sound review of the application of the method.

Fuzzy Set Ideal Type Analysis

Fuzzy set ideal type analysis was developed by Jon Kvist (1999; 2007), who applied it to compare Nordic welfare state regimes to pre-conceived ideal types. As the name indicates, the approach builds on fuzzy-set QCA (Ragin 2000; 2008). However, unlike set-theoretic analysis, fuzzy set ideal type analysis does not seek to identify necessary and/or sufficient conditions nor does it aim to develop an explanation for an outcome. Instead, fuzzy set ideal type analysis is directed at *systematic empirical comparison* and *typological theorizing*.

The approach makes use of the fact that fuzzy sets describe a property space, where each case can be located in relation to pre-conceived ideal types. In empirical reality, most cases will not be "perfect" expressions of an ideal type (equated with a fuzzy score of 1) but they may come close to that ideal (fuzzy scores less than 1 but larger than 0.5). Fuzzy set ideal type analysis can be particularly fruitful where a body of theory exists from which to derive distinct ideal types. For example, research on democracy and democratic subtypes (Lijphart 1968), organization research (Fiss 2011), or state behavior in international security (Elman 2005) would fit this description.

While less well-known than some of the other QCA variants, fuzzy set ideal type analysis has been applied mostly for the study of welfare state regimes (Hudson and Kühner 2012; Vis 2007; 2010), and various dimensions of social policies (An and Peng 2016; Ciccia and Verloo 2012;

Gran 2003), but there have also been applications in the areas of public health (Saltkjel et al. 2017) and communication (Büchel et al. 2016).[8]

Fuzzy Set Ideal Type Analysis: An Example

Let us have a look at an example, to see how fuzzy set ideal type analysis works in practice. As part of her analysis of welfare state reform in advanced democracies, Barbara Vis (2010) also conducted a fuzzy set ideal type analysis, in addition to standard QCA analyses. Table 8.7 summarizes the five types of welfare regimes that Vis derived from the literature (Vis 2010, 60). We can see that the ideal types are defined along three conditions: *activation* (A), *benefit generosity* (G), and *employment protection* (P). It follows that there are eight different types of how these three conditions can be combined. For five of these, Vis assigned distinct labels because they match the definition of different welfare and workfare regimes that are discussed in the literature. For instance, *liberal welfare* is conceived as being represented by the configuration ~A · ~G · ~P, or the absence of all three conditions, whereas *social democratic welfare* is seen as being represented by the presence of all three, as in A · G · P. How many distinct labels are needed? Naturally, this will depend on the context of a given study, but it is rare that all logically possible configurations can be filled with theoretical ideal types. However, in order to make use of fuzzy set ideal type analysis, there should be clearly distinguishable theoretical types that can be described as configurations. Otherwise, the approach would provide little additional value.

Table 8.7 Fuzzy-Set Ideal Types

Ideal type	Activation	Generosity	Protection
Social democratic welfare	●	●	●
Generous workfare	●	●	⊗
Conservative welfare	⊗	●	●
-	●	⊗	●
Lean workfare	●	⊗	⊗
-	⊗	⊗	●
-	⊗	●	⊗
Liberal welfare	⊗	⊗	⊗

Data source: Vis (2010: 60); black circles indicate the presence of a condition, crossed-out circles its absence.

What to do with these ideal types? Table 8.8 displays partial results from the empirical analysis that Vis conducted in her study (the table only shows results for France and the Netherlands). As we can see, data was gathered for three different years (1985, 1995, and 2002), which allows the examination of trends over time. For instance, we can see that France stayed within the *conservative welfare* regime, although its membership decreased between 1995 and 2002 and its membership score in *liberal welfare* increased during the same time period. The Netherlands, by contrast, shifted from *conservative welfare* to *liberal welfare* between 1985 and 2002, whereas in 1995 the country was right in between these two ideal types. At the same time, fuzzy set ideal type analysis acknowledges nuance by showing that each case only approximates a certain ideal type and often contains traces of various types. We can imagine the ideal types as being situated in the corners of the *attribute space* (see Figure 3.4) and the cases at various points inside this space. For instance, France in 2002 has a fuzzy-set membership score of 0.40 in *liberal welfare*, which means it is rather outside the conceptualized ideal type, whereas the Netherlands in 1985 closely resemble the *conservative welfare* ideal type (fuzzy set membership of 0.82), even though there are also traces of other types.

Table 8.8 Membership in Fuzzy Set Ideal Types

Ideal type	A	G	P	France		
				1985	1995	2002
Social democratic welfare	●	●	●	0.07	0.24	0.40
Generous workfare	●	●	⊗	0.07	0.05	0.05
Conservative welfare	⊗	●	●	0.75	0.76	0.60
Lean workfare	●	⊗	⊗	0.07	0.05	0.05
Liberal welfare	⊗	⊗	⊗	0.09	0.05	0.05

Data source: Vis (2010: 65); black circles indicate the presence of a condition, crossed-out circles its absence.

As the example illustrates, fuzzy set ideal type analysis can be a fruitful tool for typological work. This resonates with methodologists' renewed interest in typologies (Collier et al. 2008; Elman 2005; George and Bennett 2005; Goertz 2020). What is required, however, are strong theoretical foundations to derive distinct ideal types, which are most often found in established research areas.

Mello, Patrick A. (2021) *Qualitative Comparative Analysis: An Introduction to Research Design and Application,* Washington, DC: Georgetown University Press, Chapter 8.

Related Methods and Approaches

This chapter has looked into multi-value QCA, temporal QCA, two-step QCA, and fuzzy-set ideal type analysis – as the most common variants and approaches under the big tent of set-theoretic methods. While temporal QCA remains an area that is of particular methodological interest, but which has spawned few empirical applications, the other three variants have seen a healthy share of usage, even though crisp and fuzzy-set studies still comprise the vast majority of published empirical work (mirrored in the survey results in Chapter 2). That being said, there are a several related methods and approaches that should be mentioned to give a broader picture of the field, even though it is beyond the scope of this book to provide complete introductions.

The first of these is the *MDSO-MSDO* procedure as formalized by Gisèle De Meur, Dirk Berg-Schlosser and Alain Gottcheiner (Berg-Schlosser and De Meur 2009; De Meur and Gottcheiner 2009). MDSO stands for *most different cases, similar outcome*, while MSDO refers to *most similar cases, different outcome*. This is a technique for the pairwise Boolean comparison of cases and conditions. This can be used, for instance, to select a suitable number of conditions "that could be used with most success in explaining the phenomenon under study", as De Meur and Gottcheiner suggest (2009, 215). As such, MDSO-MSDO can serve as a formalized way to filter out less relevant conditions from a larger pool of potential conditions, before the actual QCA analysis. This is the way how Haesebrouck (2017) applies the technique, as a *preceding step* to his crisp-set QCA of UN peacekeeping contributions.

Then there is *Necessary Condition Analysis* (NCA), as developed by Jan Dul. NCA encapsulates a distinct methodology for the identification of necessary conditions in data sets (Dul 2016; Dul et al. 2020). Rather than working with the metric of consistency, as QCA does, NCA employs different *levels* of conditions, as in *condition X is necessary for outcome Y at a certain level of X* (Dul 2016). From a QCA perspective, NCA can thus be seen as a complementary method to further assess empirical necessary conditions with additional metrics, because NCA can make *degree statements* about necessity. It also appears that due to the more discriminate measures of fit, QCA tends to identify fewer necessary conditions than NCA. This means that studies with strong theoretical expectations of necessary conditions might be well advised to run NCA complementary to their QCA analysis. A summary of NCA and its relation to QCA is provided in Vis and Dul (2018).[9]

Finally, there is *Coincidence Analysis* (CNA), a Boolean method developed by Michael Baumgartner that aims to identify complex causal structures with multiple outcomes on the basis of regularity theory (Baumgartner 2013; Baumgartner and Ambühl 2020). In contrast to most of the approaches and techniques introduced so far in this chapter, CNA was explicitly designed as an *alternative* to QCA, with its own terminology and analytical protocol. Among other important differences, CNA does *not* use a truth table, as Baumgartner and Mathias Ambühl explain: "Contrary to QCA, which transforms the data into an intermediate calculative device called a *truth table*, the CNA algorithm operates directly on the data" (Baumgartner and Ambühl 2020, 533, original emphasis). Another difference is that because CNA seeks to establish *causal chains* between variables, it requires no prior determination of which condition is the outcome and what are the explanatory conditions.[10] Finally, contrary to QCA, CNA derives a single solution, which emphasizes parsimony (see Chapter 9). In sum, CNA clearly contains several promising features and has been undergoing a dynamic development in recent years. Yet, from a QCA perspective, the bottom line is that CNA entails an entirely different methodology and users should be aware of these differences (Haesebrouck and Thomann forthcoming). This applies particularly to some of the *case-oriented* aspects of QCA, as the truth table analysis and the substantive, theory-grounded treatment of logical remainders are both not possible with CNA. Instead, CNA takes an "idealist" perspective that emphasizes formal logical coherence (Schneider 2018). Hence, interested users should weigh the potential benefits and drawbacks before deciding whether their research aims are better served with QCA or the alternative proposed by CNA.

Box 8.3 MDSO/MSDO and csQCA: EU Military Operations (Haesebrouck 2017)

Using MDSO/MSDO and Crisp-Set QCA to Study EU Member State Participation in Military Operations

By Tim Haesebrouck (*Ghent Institute for International Studies, Ghent University*)

Although the EU member states have similar interests, alliance ties and domestic political systems, their patterns of military engagement differ significantly. In my article (Haesebrouck 2017), I employed QCA to find out what combinations of conditions motivate or block EU member state participating in military operations. I choose QCA because prior research suggests that participation in military missions results from a complex interplay between international- and domestic-level conditions. Therefore, QCA and its ability to capture complex causal relations (multiple conjunctural causation) makes it especially suited for answering my research question. I examined EU member state contributions to five military operations (EUFOR Congo, EUFOR Chad, UNIFIL, the 2011 Libya intervention and the air strikes against the self-proclaimed Islamic State). In line with the possibility principle, which suggests to only include negative cases in which the outcome is possible, I only selected the member states that had the necessary military capabilities to participate in the operations. This resulted in a total of 109 member state-operation dyads.

To find potential explanatory conditions, I conducted a review of the extensive academic literature on military intervention. This resulted in a total of 22 plausible explanatory conditions. Given that only 4–7 conditions should generally be included in QCA, I applied a less-known configurational method to select conditions: Most Similar Different Outcome/

Most Different Similar Outcome (MSDO/MDSO). As its name suggests, this method allows to find the similarities between the most different cases with a similar outcome and the differences between most similar cases with a different outcome. After the MDSO/MSDO analysis showed which conditions had most explanatory potential, I tested 12 alternative models that included between three and seven conditions. I decided to focus on a model that included four conditions and was theoretically coherent, explained the largest share of the cases and produced a truth table with few contradictory configurations.

Six of the sixteen rows of the truth table corresponded to contradictory configurations. To code the outcome column of these rows, I took a look at the cases that deviated from the general pattern and noticed that many of these could be explained by case-specific, idiosyncratic, circumstances. Portugal, for example, did not participate in the 2011 Libya intervention, but was located in the same truth table row as 14 cases of military participation. However, given that the non-participation of Portugal could be explained by a political crisis, I decided to assign an outcome score of 1 to the truth table row. Moreover, I noticed that many deviant cases were non-participants in the air strikes against ISIS. Therefore, I decided to conduct a separate analysis for this operation, which included two conditions that were only relevant for this operation: constitutional restrictions and the presence of foreign fighters.

The resulting solutions for the presence and absence of military participation showed that the outcome in three out of four cases can be explained by four conditions, and more than four out of five cases if the air strikes against ISIS was analyzed separately. Combining MDSO/MSDO with QCA, thus, allowed me to arrive at a concise explanation for the pattern of military participation of the EU member states in five military operations.

Notes

[1] Schneider and Wagemann (2012, 7).

[2] As will be discussed, the set-theoretic status of multi-value QCA is contested, but the analytic procedure for mvQCA follows the same principles laid out for csQCA and fsQCA.

[3] Multi-value QCA can be conducted with most software packages. The TOSMANA software (Cronqvist 2019), including a QCA add-in for Excel, is available at: www.tosmana.net.

[4] As an alternative, condition values can also be written in subscript (e.g., $employment_0$, $employment_1$, $employment_2$).

[5] Mannewitz (2011) provides a discussion of the two-step approach, combined with suggestions on how to integrate it in mvQCA and the analysis of necessary conditions.

[6] See also the separate *infobox* by Maria Brockhaus, Jenniver Sehring, Kaisa Korhonen-Kurki, and Monica Di Gregorio, where the authors share some insights on the larger research project behind their QCA studies (Brockhaus et al. 2017; Korhonen-Kurki et al. 2014).

[7] According to Schneider and Wagemann (2012, 254), "The second step consists of constructing truth tables for each outcome enabling context from step one and the proximate conditions", which would imply *multiple* truth table analyses in step two. However, it appears that Tomini and Wagemann (2018) ran a single truth table analysis during the second step, inserting all identified paths into the same analysis. This flexibility underscores that the two-step approach is a mere *guideline* to limit the number of conditions, which can be adapted depending on the research context of a given study.

[8] Though not explicitly using fuzzy set ideal type analysis, Ege (2017) conducts a similar "ideal-type" comparison on the autonomy of international public administrations.

[9] See also the critical exchange on NCA between Thiem (2018) and Dul et al. (2018).

[10] Comparisons of QCA and CNA are provided, from various perspectives, in Duşa (2019, 214-25), Baumgartner and Ambühl (2020), and Haesebrouck and Thomann (forthcoming). Notably, Zhang (2017) examines the minimization steps in CNA, finding that "there are situations in which the method's output apparently rules out the true causal structure" (2017, 92).

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