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The Added Value of Multi-Value QCA

Response to Vink & van Vliet and Thiem

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Abstract

This paper attempts to contribute to the discussion on the added value of mvQCA, which has been the subject of a very thorough debate between Vink and van Vliet (2009, 2013) and Thiem (2013). It argues that both sides largely overlook the most important strength of mvQCA: its ability to capture the impact of other variables on the degree a condition's presence is needed to produce an outcome. After expounding the need to capture this dimension of causal complexity, the paper demonstrates that mvQCA is the only QCA-variant capable of straightforwardly doing so by refuting the five reasons Vink and van Vliet provide to question the method's added value.

Introduction

In a recent article, Vink and van Vliet [VvV] (2009) critically assess the strengths and weaknesses of multi-value QCA and provide five reasons to doubt the method's added value. With the goal of opening a more nuanced debate on the potentials and pitfalls of mvQCA, Thiem (2013) gave several good arguments to refute these reasons. VvV (2013) were however not fully convinced and reiterated their doubts on the usefulness of the multi-value variant of QCA. Unfortunately, the most important strength of mvQCA is largely overlooked by both sides of the debate: contrary to other QCA-variants, mvQCA can capture the impact of other variables on the degree a condition's presence is needed to produce an outcome. After expounding the benefits of capturing this dimension of causal complexity, current contribution demonstrates that mvQCA is the only QCA-variant that is capable of doing so by refuting the five reasons why VvV question the method's added value.

Multi-Value QCA and Causal Complexity

One of the key strengths of all QCA-variants is that they allow for a complex form of causality, captured under the expression "multiple conjunctural causation". This implies that (1) more often than not, phenomena are produced by a combination of conditions (2) generally, several of such combinations can cause the same outcome and (3) causality is asymmetric, meaning that the inverted explanation for the presence of a phenomenon does not automatically imply the absence of this phenomenon (Rihoux, 2003, p. 353; Wagemann & Schneider, 2010, pp. 383-385). From this complex conception of causality follows that the impact of a condition is determined by the context in which it takes place.

This corresponds with everyday experience, as Ragin (1987, p. 23) illustrates by pointing to the fact that "a funny joke told in the wrong setting can fall flat". A context can however also determine to what extent a condition has to be present to have a certain causal effect. A joke has to be very funny to cause the same amount of laughter at a funeral as an ordinarily funny joke in a bar, while it does not even have to be funny to do so if the audience is drunk. This directly follows from the concept of multiple conjunctural causation. If the effect of a cause "depends on the values or levels of other causal variables" (Ragin, 1987, p. 33), these other variables can also determine to what extent it has to be present to produces a certain outcome.

In all probability, this dimension of causal complexity applies to many phenomena that interest social scientists. Consider for example the complex causal relationship between electoral cycles and a government's inclination to resort to the use of military force abroad (Williams, 2013, pp. 451-452). According to diversionary theories of war, governments are more likely to resort to the use of force when the next election is close by. This is because they might hope to create a "rallying around the flag effect", thereby enhancing their chances at reelection. Theories on casualty aversion and democratic peace, on the other hand, expect governments to be careful not to upset the public before an election by engaging in costly military adventures. These diverging theoretical expectations are not necessarily contradictory, since the impact of electoral cycle can be expected to depend on other factors, most importantly government popularity.

It seems self-evident that only unpopular governments will be tempted to deploy military force for diversionary purposes. Since these already face a high risk at electoral defeat, they have not much to lose and a lot to gain from pursuing this dodgy strategy. Popular

governments, on the other hand, will not put their favorable electoral position at risk for merely the possibility of achieving a greater victory. At the beginning of an electoral cycle, government popularity can however be expected to have no impact on the use of force. This is because executives are less driven by electoral calculations when the next election is still in a distant future. In the middle of a cycle, government popularity probably does matter, but in yet another way than at the end of a cycle. Because of their electoral surplus, popular governments might still be willing to engage in military action, since they do not risk losing all their chances at reelection when things go awry. Unpopular governments do face this risk and, contrary to the last year before an election, might hope to have the time to improve their chances without pursuing the risky strategy of diversionary warfare.

Three very probable conjectures follow from the above:

1. At the beginning of an electoral cycle, all governments resort to the use of force.
2. At the middle of an electoral cycle, only popular governments resort to the use of force.
3. At the end of an electoral cycle, only unpopular governments resort to the use of force.

The extent the condition “electoral cycle” or “distance to next election” has to be present to cause the use of force, can thus be expected to be determined by the value of the condition government popularity. This also holds for the absence of the use of force, which can either occur at the end of an electoral cycle if the a country is ruled by a popular government or at the middle of an electoral cycle if the country is ruled by an unpopular government. Similar to ‘traditional’ multiple conjunctural causations, this causal relation is thus asymmetric. While the presence of the beginning of an electoral

cycle explains the presence of the use of force, this outcome will only be absent in specific cases of it absence.

The extent to which a condition has to be present to have a certain causal effect can thus be dependent on the presence or absence of other conditions. As will become clear in the reassessment of both VvV's claims and Thiem's response, neither the fuzzy set, nor the crisp set variant of QCA is able to straightforwardly capture this dimension of causal complexity.

The Alleged Pitfalls of mvQCA

VvV provide five reasons for questioning mvQCA's added value. These can however be refuted by demonstrating that mvQCA is the only QCA-variant capable of capturing the dimension of causal complexity described above.

"Claim 1: The observation that in mvQCA applications mostly continuous base variables have been calibrated into multi-value sets indicates, first of all, a misuse of mvQCA and, second, puts doubt on the need for mvQCA." (Vink & Vliet, 2013, p. 208).

VvV only see a case for mvQCA when dealing with categorical base variables, such as race or religion (2009, pp. 270-271,289). Thiem (2013a, pp. 199-200) agrees with this claim, and only qualifies VvV's assertion that mvQCA was barely used for categorical base-variables. According to both sides of the debate, fuzzy set QCA (fsQCA) is thus clearly superior when only continuous base variables are used. However, no matter whether categorical or continuous base variables are used, fsQCA is not capable of capturing causal relations in which the context determines the extent a condition's presence is required to cause an outcome.

This can be illustrated with the example from the previous section, in which all variables can be operationalized with a continuous base variable. The time remaining until next election, for instance, constitutes a very straightforward indicator for operationalizing "begin electoral cycle" (EC). Countries at the beginning of a cycle (e.g. over 3 years till next election) could be assigned a score of 1, countries at the middle of a cycle (e.g. between 3 and 1 year till next election) a score of 0.5 and countries at the end (e.g. less than 1 year till next election) a score of 0. Data extracted from opinion polls could be used to operationalize government popularity (POP), conflict duration or intensity to calibrate use of force (FORCE). For clarity's sake, these variables are however dichotomized in the example below. Assuming the above theoretical assumptions are correct, the following combinations of fuzzy membership scores on the conditions and the outcome are possible.

Table 1: Fuzzy Membership Scores

Comb	EC	POP	FORCE
1	1	1	1
2	1	0	1
3	0.5	1	1
4	0	0	1
5	0.5	0	0
6	0	1	0

Like all QCA-variants, fsQCA uses a truth table to examine causal relations. The latter lists all logically possible combinations of conditions and the associated outcomes. In fsQCA, the construction of a truth table starts with calculating each case's membership score in every possible combination, using logical AND. Subsequently an outcome value is assigned to each row. A combination of conditions is assumed to cause an outcome if the membership scores in this combination are consistently below or equal to the

corresponding scores in the outcome. This is calculated with the formula $\sum(\min(Xi, Yi)/\sum(Xi)$, in which X denotes the membership scores in the combination of conditions and Y the scores in the outcome. The resulting value is the consistency score, which can vary between 0 and 1. An outcome value of 1 will be assigned to rows with a high consistency score.

If one case is included for each possible combination, this results in the following truth table. Only the consistency of the first row is sufficiently high to assign it an outcome-value of 1. This would lead the researcher to the conclusion that only popular governments that are at the beginning of an electoral cycle will resort to the use of force. He will thus fail to uncover the three causal combinations that were assumed to cause military deployment. This is because fsQCA assumes that the intermediate presence of a condition basically has the same causal effect as its full presence in every possible context. Only the extent to which it affects the outcome is assumed to differ. In other words, if the full presence of a condition leads to the presence of an outcome in a certain context, it is assumed that, in the same context, its intermediate presence will lead to an intermediate presence of the outcome. fsQCA is therefore unable to capture the causal effect of an intermediate category if, depending on the context, it can have a different impact than the full presence of the corresponding condition.

Table 2: Truth Table fsQCA

	Conditions			Outcome
row	EC	POP	Consistency	FORCE
1	1	1	1	1
2	1	0	0.67	0
3	0	0	0.67	0
4	0	1	0.33	0

Row 2, for example, represents the combination of the presence of "begin electoral cycle" and the absence of "government popularity" which is assumed to be sufficient for the use of force. Two types of cases have a non-zero membership score in this row, and thus affect its consistency value. Countries with an unpopular government that are at the beginning of an electoral cycle have a score of 1, countries with an unpopular government at the middle of a cycle a score of 0.5. Only the former resort to the use of force and thus have a score of 1 in the outcome, the latter do not, and thus have a score 0. Scores in the condition thus exceed the corresponding scores in the outcome in the cases at the middle of an electoral cycle, causing the consistency score of this row to drop. The latter wrongfully leads researchers to the conclusion that being an unpopular government at the begin of a cycle is not sufficient for the use of force, based on the observation that unpopular governments do not use force at the middle of a cycle.

The argument would also hold if all variables were calibrated to continuous fuzzy sets. The following thresholds could be used for electoral cycle: 3 years till next election for full membership, 1 year for the crossover treshold and 0 years for non-membership. If the above conjunctions are correct, two cases with 0.6 in the combination EC{1}POP{0}

would have a different score in the outcome. A case with a score of 1 in EC and 0.4 in POP would have a score of at least 0.6 in FORCE, since it is an unpopular governments at the beginning of an electoral cycle and thus expected to resort to the use of force at least to the extent that it is a member of this combination. A case with 0.6 in EC and 0.4 in POP would however definitely have a score below 0.5 in the outcome, since it is an unpopular government at the middle of an electoral cycle and thus expected not to resort to the use of force. This would cause the consistency score of the row to drop, again wrongfully leading researchers to the conclusion that being an unpopular government at the beginning of a cycle is not sufficient for the use of force, based on the observation that unpopular governments do not use force at the middle of a cycle.

fsQCA is thus not capable of straightforwardly capturing causal relationships in which the intermediate presence of a condition does not have the same impact as the condition's full presence in every possible context. This would require using a different fuzzy set for every category of the condition that is expected to have a specific causal effect. The resulting truth table would be capable of capturing the specific causal effect of each of these categories. However, since the procedure for minimizing this truth table is basically the same as in crisp set QCA (Thiem, 2013b, p. 8); the researcher would eventually run into the same problems that are identified in the next sections. The allegedly superior fuzzy set technique thus does not constitute an alternative to mvQCA every time continuous base-variables are used.

"Claims 2 and 3: Crisp-set QCA can be used as an alternative to multi-value QCA by creating a binary condition for each category except one, as long as the impossible logical

remainders are set to ‘‘don’t care’’ or are excluded from the truth table.” (Vink & Vliet, 2013, p. 210).

Both VvV and Thiem concur with these claims, but disagree on whether it is good practice to use impossible logical remainders for reducing complexity. Impossible remainders are combinations of conditions that cannot exist in the real world (Schneider & Wagemann, 2012, p. 206). Contrary to Thiem and in line with VvV, I do not see the problem with making these available for reduction in order to arrive at a less complex solution. The latter is clearly in line with the parsimony principle of “expressing things as simple as possible, but not simpler” (Berg-Schlosser, Meur, Rihoux, & Ragin, 2009, p. 10). Next to resulting in less complex formula’s, the only consequence of using impossible remainders in Boolean minimization is that the solution term applies to these remainders; which is certainly not a problem.

The solution term of a QCA corresponds to a sufficient condition, i.e. a condition whose presence guarantees the presence of an outcome. Since impossible remainders can, by definition, never exist; they can never correspond to cases of the causal combination where the outcome is absent. If they are used for arriving at a more parsimonious solution term, the latter will be just as valid as the solution term that was arrived at without these remainders. Furthermore, and contrary to ‘possible’ remainders, impossible remainders can be included without increasing the probability that, in future research, cases will be observed that contradict statements of sufficiency. Their inclusion thus does not endanger the objective of modest generalization, of formulating propositions applicable to non-observed cases (Berg-Schlosser et al., 2009, p. 12). If anything, including impossible remainders is thus less problematic than including possible remainders.

There is however a more serious problem with the proposed procedure: the specific causal effect of the category for which no binary condition was created can disappear from the solution term. Contrary to both VvV and Thiem's expectations, the procedure proposed by the former does not lead to the same formula as mvQCA. The table below includes two truth tables, both of which assume that the above theoretical assumptions are correct. On the left-hand side is a multi-value truth table in which electoral cycle is trichotomized in begin cycle (value of 2 on condition EC), middle cycle (value of 1 on condition EC) and end cycle (value of 0 on condition EC). On the right-hand side, two crisp conditions are used instead, as suggested by VvV. EC2 indicates the beginning of electoral cycle; EC1, middle of electoral cycle.

Table 3 Two equivalent Truth Tables

	Multi Value Conditions			Crisp Conditions		
Comb	EC	POP	FORCE	EC 2	EC 1	POP
1	2	1	1	1	0	1
2	2	0	1	1	0	0
3	1	1	1	0	1	1
4	0	0	1	0	0	0
5	1	0	0	0	1	0
6	0	1	0	0	0	1
7	-	-	?	1	1	1
8	-	-	?	1	1	0

Minimization of the multi-value conditions yields the following solution (M1), in which prime implicant (PI) term EC{2} covers combination 1 and 2, EC {1}POP{1} combination 3 and EC{0}POP{0} combination 4.

$$EC\{2\} + EC\{1\}POP\{1\} + EC\{0\}POP\{0\} \rightarrow FORCE \text{ (M1)}$$

Even if logical remainders are used, Boolean minimization of the crisp condition yields a somewhat different solution (M2), in which EC{2}results from the minimization of combination 1 and 2, EC{1}POP{1} from 3 and 7 and EC1{0}POP{0} from 2 and 4.

$$EC2\{1\} + EC\{1\}POP\{1\} + EC1\{0\}POP\{0\} \rightarrow FORCE \quad (M2)$$

Prime implicant terms EC2{1} and EC{1}POP{1} basically have the same denotation as the first two terms of the multi-value solution. The third PI, EC1{0}POP{0}, however, has a different denotation than the third term in M1. In the latter it describes the combination of "end electoral cycle" with "unpopular government", in M2 the combination of "not middle electoral cycle" and "unpopular government". The third PI of M1 clearly has more explanatory power than the third implicant of M2, since the specific causal effect of the not-included binary condition, "begin electoral cycle", got lost in the latter. While it is correct that EC1{0}POP{0} is sufficient for the use force, this term refers to two very different causal mechanisms. First, it implies that countries with an unpopular government will use force at the beginning of an electoral cycle. This is however already more precisely covered by the first implicant, that indicates that government popularity is not important in the beginning of an electoral cycle. Secondly, it implies that the use of force will occur at the end of an electoral cycle in countries with unpopular governments. Unfortunately, the latter conjunction cannot straightforwardly be derived from the solution term.

An even more disturbing downside of the crisp set alternative proposed by VvV is that the choice of the category that is not replaced by a binary condition affects the result of the analysis. If instead of "end cycle", "begin electoral cycle" is not included as a binary

condition, the result again differs from both M1 and M2. This can be illustrated with the truth table below, in which EC 0 denotes “end electoral cycle”.

Table 4 Alternative csQCA Truth Table (1)

	Crisp Conditions			
Comb	EC 0	EC 1	POP	FORCE
1	0	0	1	1
2	0	0	0	1
3	0	1	1	1
4	1	0	0	1
5	0	1	0	0
6	1	0	1	0
7	1	1	1	?
8	1	1	0	?

Boolean minimization of this truth table again yields a different solution (M3).

$$\text{EC } 0\{0\}\text{POP}\{1\}+\text{EC } 1\{0\}\text{POP}\{0\} \rightarrow \text{FORCE (M3)}$$

EC 0{0}POP{1} results from minimization of combination 1 and 3 and implies that popular governments will use force when it is not the end of a cycle, EC 1{0}POP{0} results from combination 2 and 4 and implies that unpopular ones will use force when it is not the middle of a cycle. While correct in terms of sufficiency, the specific causal effect of the category of electoral cycle that was not included in the analysis, “begin cycle”, again disappears.

There is however a different minimization scheme possible, which results in the following formula (M3’):

$$\text{EC } 0\{0\}*\text{EC } 1\{0\}+ \text{EC } 1\ (1)*\text{POP}(1)+ \text{EC } 0\ (1)*\ \text{POP}\ (0) \rightarrow \text{FORCE (M3'')}$$

M3' basically has the same denotation as M1. The first PI, EC 0{0}*EC 1{0}, results from the minimization of combination 1 and 2 and implies that governments use force when it is neither the end, nor the middle of a cycle. From this logically follows they will use force at the beginning of a cycle. This PI could be included in M3, making it possible to straightforwardly derive the specific causal effect of the excluded category from the formula. The PI would however be logically redundant, since the two combinations it covers are already explained by the two other PI's.[1] Its inclusion would thus require a conscious decision of the researcher not to remove it from the analysis, while in mvQCA it is automatically included in the formula.

The two remaining PI's in M3' would not only be logically redundant in M3, they also result from the minimization of an existing combination with an impossible remainder: combination 3 with remainder 7 for EC 1 (1)*POP(1); combination 4 with remainder 8 for EC 0 (1)*POP (0). Although the use of impossible remainders is not problematic, no researcher will prefer an implicant that resulted from minimization with remainders over one where no remainders were used. In all probability, researchers will thus arrive at solution term M3 instead of M3'. As will be argued in the refutation of VvV's fifth claim, this is unfortunate because the causal impact of each specific condition value can be much more straightforwardly derived from M3'.

The proposition that csQCA can be used as an alternative to mvQCA "by creating a binary condition for each category except one" is thus clearly not correct (Vink & Vliet, 2013, p. 210). Not only does it create the risk of overlooking the specific causal impact of the

[1] On logically redundant prime implicants see Schneider and Wagemann (2012, pp. 109-110).

category for which no binary condition was created, the choice of the excluded category also determines the conjunctions included in the resulting formula.

"Claim 4: There is no need to include a condition for each category of a multichotomous nominal variable; theoretical expectations about the relation between some condition and an outcome should determine which category should be included in the analysis."(Thiem, 2013a, p. 211).

VvV also doubt the added value of mvQCA for theoretical reasons. They argue that it is not necessary to include every category of a multichotomious variable in an analysis, because researchers generally have reasons to expect a specific effect of only one category. They illustrate their point with an example Cronqvist and Berg-Schlosser (2009, pp. 70-71) use to demonstrate the added value of mvQCA: the impact of the colors of a traffic light on car accidents. In mvQCA, every case can be assigned a value that corresponds to one of the three colors. VvV however claim that it is not necessary to include all three colors, but only the color of which the researcher expects that it affects the occurrence of car crashes.

VvV actually make two questionable assertions with this fourth claim. First of all, they expect that only one category of a multi-value condition is theoretically useful and, secondly, that a researcher can know in advance which one. Thiem (2013a, pp. 203-204) rightfully disagrees with the second point, but also the first claim seems questionable. As already pointed out throughout current contribution, several categories of a conditions might be relevant for explaining the occurrence of a phenomenon in different contexts. Strikingly, this obviously also holds for the traffic light example. A yellow light might

cause an accident in combination with a driver that is in a hurry to get to his destination, since the latter might speed up to pass it before it turns to red. Even a hurried driver can however still be expected not to risk crossing a red light. The latter can however cause car crashes in combination with a distracted driver, who does not notice the traffic light, crosses it and thereby causes an accident. Depending on the driver that approaches a traffic light, different colors might thus have different consequences.

mvQCA has the distinctive advantage of being able to straightforwardly take into account the different impact of each different category of a multi-value condition. VvV (2009, p. 286) actually acknowledge this:

"One could argue that introducing a new intermediate category allows us to modify theoretical expectations, (…). And one may have good theoretical reasons to expect a specific causal relevance of an intermediate category, possibly in combination with other conditions"

They however point to the fact that in most mvQCA applications, new intermediate categories are introduced in a purely inductive manner, based on a form of cluster analysis. According to VvV (2009, p. 286), the latter constitutes a problem "when drawing general conclusions on the basis of only a small number of cases."

While these critiques might hold for most mvQCA-applications, they do not automatically apply to mvQCA as a method. First of all, the multichotomisation of a condition is not necessarily a purely inductive affair. As the example introduced in the first section demonstrates, explicit hypotheses about the effect of a specific category of a condition in different contexts are sometimes possible. mvQCA could therefore be applied in a more

deductive manner, to test explicit (conjunctural) expectations on multi-value conditions. However, mvQCA could also be fruitfully applied in an inductive manner. Most theories do not assert that conditions work the same way in different contexts, but also do not postulate hypotheses about the extent they have to be present in a certain context. Therefore, mvQCA's ability to introduce multi-value conditions seems to make it a very valuable tool for developing more fine grained theories.

This goal can be achieved during the resolution of contradictory configurations. The latter are combinations of conditions that characterize cases where the outcome is present, as well as cases where the outcome is absent. When these contradictions can be attributed to cases with an intermediate value in one of the conditions, this can indicate that the extent this condition has to present to have a certain causal effect is determined by other conditions. However, VvV rightfully argue that it is problematic to solely use technical criteria, like cluster analyses, to introduce new categories. Instead, substantive and/or theoretical arguments should support that each value of a condition represents a qualitatively different category, capable of having a specific causal effect. Furthermore, during the interpretation of the results of the QCA, the researcher should provide a meaningful explanation of the specific causal effect of these categories in different contexts. If these good practices are observed, mvQCA could be a very useful instrument for developing new conjunctural theoretical arguments. mvQCA can thus be applied for both inductive as well as deductive purposes.

"Claim 5: The set-theoretic status of mvQCA differs from both csQCA and fsQCA because set membership scores in multi-value sets refer to membership of multiple,

instead of two set categories; in mvQCA, every category is a set in itself." (Vink & Vliet, 2013, p. 212).

According to VvV, the different set-theoretic status of mvQCA constitutes the most important downside of this QCA-variant (2009, p. 272). Thiem (2013a, p. 9) refutes this claim by asserting that mvQCA is actually a generalization of crisp set logic which "simply extents the number of categories beyond csQCA's two possible states." He (2013, p.8) points out that much of VvV's confusion is caused by the incoherent notional systems used in crisp set and multi value QCA, which respectively use membership-score and value notation. In order to solve the confusion, Thiem (2013, p. 8), quite brilliantly, develops a unified notational system for al QCA-variants, in which the membership score S_i of some case i in value $\{v_l\}$ of set S_j is given by the value-score term $S_j\{v_l\}S_i$.

Unfortunately, Thiem does not explicate the set-theoretic implications of his notational system and confusingly uses phrases like "category of a set" and "set-value". Since cases are attributed membership scores in these concepts, it is not clear how they differ from actual sets. Adding to the confusion, Thiem (2013, p. 205) only uses the set-value indicator for multi-value condition C_2 in the illustration of his notational scheme. For crisp condition C_1, this indicator is constantly set to 1. This leads VvV to the conclusion that the value of 0 has lost the meaning of negation or absence of category in mvQCA. The latter adds to their suspicion that mvQCA has a diverging set-theoretic status (2013, p. 212).

This suspicion is however misguided. While VvV correctly assert that multi-value conditions consist of multiple sets combined in one, this does not differentiate mvQCA from the other QCA-variants. In crisp set QCA, two values are possible for each condition

and each of these values refers to a different set. Crisp condition "government popularity" has two possible values, "popular government" and "non-popular government", which respectively refer to the set of countries with a popular government and the set of countries with a non-popular government. Cases can have a membership score of either 1 or 0 in these sets.

In Thiem's notational scheme, the composite nature of the conditions in crisp set QCA is represented in the set-value indicator $\{v_l\}$. A case in the set of popular governments is represented as POP{1}1, a case outside this set as POP{1}0, a case in the set non-popular governments POP{0}1 and a case out of this set as POP{0}0. The connotation of 0 is basically the same in csQCA as in mvQCA. When it refers to a set-value, it indicates a specific set; when it refers to a membership-score, it indicates that a particular case is outside a set. Since $\{v_l\}$ refers to a value of a condition, which corresponds to an actual set, the notion of set-value is however somewhat confusing. Condition-value seems a more appropriate term.

Both crisp set and multi-value QCA thus use conditions that refer to multiple sets. The only difference between the two QCA variants is the number of values, and thus sets, that is allowed for each condition. While in csQCA the number of possible values is limited to two; in mvQCA, each condition can have an infinite number of values. An important implication of the latter is that membership in the set defined by one of the condition values cannot be deduced from non-membership in the set defined by another. The latter is possible in csQCA, in which non-membership in the set of one condition value corresponds to full membership in the set defined by the other. Therefore, traditionally, only membership scores in the set of one condition-value (generally {1}) are represented

in csQCA, from which membership in the other value is deduced. Since there are more than two condition values possible in mvQCA, non-membership in the set defined by one value does not automatically imply membership in the set of the other condition-value. This is why the condition value indicator is more clearly needed in mvQCA.

While this seems to constitute a downside of mvQCA, it is from clearly distinguishing condition-values from the absence of other condition values that mvQCA draws its distinctive strength. As noticed by Schneider and Wagemann (2012, p.47), "the complement of sets often comprises many different cases. (…) It is particularly important to take stock of this diversity when trying to attribute some causal role to the negation of a set." A downside of csQCA, is that it tends to attribute causal roles to complements of sets instead of to actual sets. This can be illustrated with the example used throughout, only this time every condition value is represented by a binary condition.

Table 5 Alternative csQCA Truth Table (2)

	Crisp Conditions				
Comb	EC 0	EC 1	EC2	POP	FORCE
1	0	0	1	1	1
2	0	0	1	0	1
3	0	1	0	1	1
4	1	0	0	0	1
5	0	1	0	0	0
6	1	0	0	1	0

Boolean minimization of this truth table results in the following formula:

EC 0{0}Popularity{1}+EC1{0}Popularity{0}→ FORCE (M4)

Contrary to M1, which was arrived at using multi-value conditions, this formula attributes a causal role to the absence of two condition values: “end electoral cycle” in the first PI, “middle electoral cycle” in the second PI. In line with Schneider and Wagemann (2012) assertion, the absence of these condition values however refer to very different cases. “Not middle electoral cycle”, for instance, refers to both countries at the end of an electoral cycle as to countries at the beginning of one. The causal effect of these condition values is very different. While the former only leads to the use of force in combination with unpopular governments, confirming the diversionary use of force hypothesis; the latter leads to the use of force independent of government popularity, confirming literature on casualty aversion and democratic peace. The specific causal effect of these values can however not straightforwardly be deduced from EC1{0}Popularity{0}, which, as mentioned above, refers to two causal mechanisms.

There is again an alternative formula possible:

$$EC\ 2\{1\}+EC0\{1\}POP\{0\}+EC1\{1\}POP\{1\}\} \rightarrow FORCE\ (M4')$$

M4’ basically denotes the same as M1 and, like the latter, is preferable to M4 because the specific impact of each condition-value can be straightforwardly deduced from it. When using the crisp conditions, the researcher however has to make a conscious decision to pick the PI’s included in this formula and not the ones included in M4. This does not constitute an obvious choice. First of all, M4’ seems somewhat more complex than M4. It includes more PI’s, which are all logically redundant when the two PI’s of M4 are included. Furthermore, 8 logical remainders were used to arrive at M4’, while only four were used to arrive at M4. In sharp contrast to the counter intuitive choices that are

required when using csQCA, a researcher automatically arrives at the formula M1 when using mvQCA.

Conclusion

Contrary to both the crisp and fuzzy set variants, multi-value QCA is capable of straightforwardly capturing the causal role of different categories of a condition. This distinctive strength can be very useful, given the extent a condition's presence is needed to produce an outcome is sometimes dependent on the context in which it occurs. Therefore, it can be essential to include different categories of a condition in an analysis. mvQCA draws this distinctive strength from clearly distinguishing each specific value of a condition from the absence of other possible condition-values. While the latter induced the need for using another notational system, it does not give mvQCA a different set-theoretic status than the other QCA variants. Suspicion regarding either the added value of mvQCA as a tool for capturing complex causal relations or its set-theoretic status therefore seems to be misguided.

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