Qualitative Comparative Analysis (QCA): State of the Art and Prospects

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Qualitative Comparative Analysis (or QCA; Ragin 1987; Ragin and Drass 1994) and its successor, Fuzzy Set Qualitative Comparative Analysis (fsQCA; Ragin 2000; Ragin, Drass, and Davey 2004; Ragin 2004a), were both developed for the analysis of small-and intermediate-N data sets, typical of those used by researchers in comparative politics and related disciplines. These techniques are designed to unravel causal complexity by applying set-theoretic methods to cross-case evidence. Their central goal is to mimic some of the basic analytic procedures that comparative researchers use routinely when making sense of their cases. The key difference between QCA and traditional case-oriented methods is that with QCA it is possible to extend these basic analytic procedures to the examination of more than a handful of cases, for example, to more than 10.[2] In fact, there is no procedural limit on the number of cases that can be studied using QCA.

In this paper, we offer a conceptually oriented introduction to QCA and discuss the state of the art in research using QCA. We begin by examining two analytic procedures commonly used by comparative researchers and contrast these techniques with correlational analysis, the main analytical engine of mainstream quantitative social science. We then present an overview of the state of the art by mapping the diversity and scope of QCA applications. Next, we lay out some general guidelines for using QCA and provide a list of more specific guidelines in the form of "best practices." One of these guidelines concerns the use of "remainders" (combinations of causal conditions lacking cases) in QCA. This leads to an in-depth presentation of one of the most powerful features of QCA: counterfactual analysis.[3] We conclude by sketching several of QCA's future prospects.

The Distinctiveness of Comparative Research

Researchers in comparative politics and related fields often seek to identify commonalities across cases, focusing on a relatively small number of purposefully selected cases. There are two analytic strategies central to this type of research. The first strategy is to examine cases sharing a given outcome (e.g., consolidated third-wave democracies) and attempt to identify their shared causal conditions (e.g., the possibility that they share presidential systems).[4] The second strategy is to examine cases sharing a specific causal condition, or more commonly, a specific combination of causally relevant conditions and assess whether or not these cases exhibit the same outcome (e.g., do cases that combine party fractionalization, a weak executive, and a low level of economic development all suffer democratic breakdown?). Both strategies are set theoretic in nature. The first is an examination of whether instances of a specific outcome constitute a subset of instances of one or more causal conditions. The second is an examination of whether instances of a specific causal condition or combination of causal conditions constitute a subset of instances of an outcome.

Both strategies are methods for establishing *explicit* connections. If it is found, for example, that all (or nearly all) consolidated third-wave democracies have presidential systems, then an explicit connection has been established between presidentialism and consolidation—assuming this connection dovetails with existing theoretical and substantive knowledge.[5] Likewise, if it is found that all (or nearly all) third-wave democracies that share a low level of economic development, party fractionalization, and a weak executive failed as democracies, then an explicit connection has been established between this combination of conditions and democratic breakdown. Establishing explicit connections is not the same as establishing correlations. For example, assume that the survival rate for third-wave democracies with presidential systems is 60%, while the survival rate for third-wave democracies with parliamentary systems is 35%. Clearly, there is a correlation between these two aspects conceived as variables (presidential versus parliamentary system and survival versus failure). However, the evidence does not come close to approximating a set-theoretic relation. Thus, in this example there is evidence of correlation (i.e., a general or *tendential* connection), but not of an *explicit* connection between presidential systems and democratic survival.

As explained in Ragin (2000), the first analytic strategy, identifying causal conditions shared by cases with the same outcome, is appropriate for the assessment of necessary conditions. The second strategy, examining cases with the same causal conditions to see if they also share the same outcome, is suitable for the assessment of sufficient conditions, especially sufficient combinations of conditions. Establishing conditions that are necessary or sufficient is a longstanding interest of comparative researchers (e.g., Goertz and Starr, 2002). However, it is important to point out that the use of set-theoretic methods to establish explicit connections does not necessarily entail the use of the concepts or the language of necessity and sufficiency, *or any other language of causation*. A researcher might observe, for example, that instances of democratic breakdown are all ex-colonies without drawing any causal connection from this observation. A simpler example: colleagues might "act out" only in faculty meetings, but that does not mean that analysts must therefore interpret faculty meetings as a necessary condition for acting out. Demonstrating explicit connections is important to social scientists, whether or not they are interested in demonstrating causation. In fact, qualitative analysis in the social sciences is centrally concerned with establishing explicit connections.

As Ragin (2000) demonstrates, correlational methods are not well suited for studying explicit connections. This mismatch is clearly visible in the simplest form of variable-oriented analysis, the 2x2 crosstabulation of the presence/absence of an outcome against the presence/absence of an hypothesized cause, as illustrated in Table 1.

Table 1: Crosstabulation of presence/absence of an outcome against presence/absence of a causal condition

	Causal Condition Absent	*Causal Condition Present*
Outcome Present	1.Cases here undermine researcher's argument	2.Cases here support researcher's argument
Outcome Absent	3.Cases here support researcher's argument	4.Cases here undermine researcher's argument

The correlation focuses simultaneously and equivalently on the degree to which instances of the cause produce instances of the outcome (the number of cases in cell 2 relative to the sum of cells 2 and 4) and on the degree to which instances of the absence of the cause are linked to the absence of the outcome (the number of cases in cell 3 relative to the sum of cells 1 and 3).[6] In short, it is an omnibus statistic that rewards researchers for producing an abundance of cases in cell 2 and/or cell 3 and penalizes them for depositing many cases in cell 1 and/or cell 4. Thus, it is a good tool for studying tendential connections.

A researcher interested in explicit connections, however, is interested only in specific components of the information that is pooled and conflated in a correlation. For example, comparative researchers interested in causally relevant conditions shared by instances of an outcome would focus on cells 1 and 2 of Table 1. Their goal would be to identify causal conditions that deposit as few cases as possible in cell 1. Likewise, researchers interested in whether cases that are similar with respect to causal conditions experience the same outcome would focus on cells 2 and 4. Their goal would be to identify combinations of causal conditions that deposit as few cases as possible in cell 4. It is clear from these examples that the correlation has two major shortcomings when viewed from the perspective of explicit connections: (1) it attends only to relative differences (e.g., relative survival rates of presidential versus parliamentary systems), and (2) it conflates different kinds of set-theoretic assessment.

It is important to remind readers that the bivariate correlation is the foundation of most forms of conventional quantitative social research, including some of the most sophisticated forms of variable-oriented analysis practiced today. A matrix of bivariate correlations, along with the means and standard deviations of the variables included in the correlation matrix, is all that is needed to compute complex regression analyses, factor analyses, and even structural equation models. In essence, these varied techniques offer diverse ways of representing the bivariate correlations in a matrix and the various partial relations (e.g., the net effect of an independent variable in a multiple regression) that can be constructed using formulas based on three or more bivariate correlations. Because they rely on the bivariate correlation as the cornerstone of empirical analysis, these sophisticated quantitative techniques eschew the study of explicit connections, as described here.

QCA, by contrast, is centrally concerned with explicit connections. It is grounded in Boolean algebra—the algebra of logic and sets—and thus is ideally suited for identifying key set-theoretic relations. An especially useful feature of QCA is its capacity for analyzing complex causation, defined as a situation where a given outcome may follow from several different combinations of causal conditions—different causal "paths." For example, a researcher may have good reason to suspect that there are several distinct "recipes" for the consolidation of third-wave democracies. By examining the fate of cases with different combinations of causally relevant conditions, it is possible, using QCA, to identify the decisive recipes and thereby unravel causal complexity.

The key analytic tool for analyzing causal complexity using QCA is the truth table. Truth tables list the logically possible combinations of causal conditions (e.g., presence of presidential versus parliamentary form of government, presence/absence of party fractionalization, and so on) and the outcome associated with each combination (e.g., whether democracies with each combination of conditions consolidate).[7] Table 2 illustrates a simple truth table with four causal conditions and sixteen causal combinations.

Table 2: Truth table with four causal conditions (A, B, C, and D) and one outcome (Y)

A	B	C	D	Y*
no	no	no	no	no
no	no	no	yes	?
no	no	yes	no	?
no	no	yes	yes	?
no	yes	no	no	no
no	yes	no	yes	no
no	yes	yes	no	?
no	yes	yes	yes	no
yes	no	no	no	?
yes	no	no	yes	?
yes	no	yes	no	?
yes	no	yes	yes	?
yes	yes	no	no	yes
yes	yes	no	yes	yes
yes	yes	yes	no	?
yes	yes	yes	yes	?

* Rows with "?" in this column lack cases—the outcome cannot be determined.

In more complex truth tables, the rows (combinations of causal conditions) may be quite numerous, for the number of causal combinations is a geometric function of the number of causal conditions (number of causal combinations = 2^k, where k is the number of causal conditions). The use of truth tables to unravel causal complexity is described in detail elsewhere (e.g., Ragin 1987; Ragin 2000; De Meur and Rihoux 2002). The essential point is that the truth table elaborates and formalizes one of the two key analytic strategies of comparative research—examining cases sharing specific combinations of causal conditions to see if they share the same outcome. The goal of truth table analysis is to identify explicit connections between combinations of causal conditions and outcomes.

The State of the Art[8]

At present, we have referenced about 250 QCA applications worldwide.[9] Most of these are English-language, although some applications have been published in French, Swedish, German, Norwegian, Finnish, and Japanese. Apart from work by Japanese scholars, the bulk of QCA applications has been developed by scholars in the U.S. and Northern Europe. It must be pointed out that in some instances it is not clear whether the authors have actually used the QCA software to perform their analyses. All the references we have identified, though (see footnote above), use the QCA Boolean logic (including the minimization procedure, one way or another). This being said, during the last few years, most (if not all) contributions now clearly indicate the use of the software, indicating that the formal tools implemented in the software are becoming better known and more widely taught.

In terms of disciplinary orientation, the largest proportion of applications—more than two-thirds—can be found in political science, political sociology, and sociology. Applications cover "classical" comparative politics topics (political parties, decision-making, social movements, revolutions, welfare states, and so on), as well as an increasing number of policy-oriented topics. In sociology, applications cover mostly topics in historical sociology, as well as organizational sociology. There is also a growing number of applications in other disciplines such as political economy, management studies, and criminology. Finally, a few applications can be found in history, geography, psychology, and education.

Although QCA is designed mainly for small- and intermediate-N research, there is substantial variation across studies in the number of cases. Quite a few applications have a very small N, as low as five cases (e.g., Kitchener et al. 2002), six cases (e.g., Vanderborght & Yamasaki 2004), and seven cases (e.g., Bruegemann & Boswell 1998; Hellström 2001). We have identified some fifteen distinct applications with ten or fewer cases. In the intermediate-N range, most applications are to be found in the broad range from 10 to 50 cases. However, several applications address between 50 and 80 cases (e.g., Williams & Farrell 1990; Rudel & Roper 1996; Nomiya 2001). Still further, some applications are to be found in the large-N domain: respectively 129 (Drass & Spencer 1987), 159 (Yonetani et al. 2003), 1936 (Ragin & Bradshaw 1991), 2964 (Amoroso & Ragin 1992) and 5755 cases (Miethe & Drass 1999). Hence, the method has been applied fruitfully in a very broad range of research designs.

The nature of the cases studied is also diverse. In most applications, cases (and outcomes) are macro- or meso-level phenomena, such as policy fields, collective actors, country or regional characteristics, and so on. However, some scholars have applied QCA to micro-level data. The number of cases ("units of observation") is sometimes increased through specific techniques, often utilizing the temporal dimension (e.g., Clément 2004: from 3 to 9 cases; Rihoux 2001: from 14 to 44 cases).

There is also substantial variation as to the number of conditions included in the analysis, though of course there is (or at least there should be) some connection between the number of cases and the number of variables (Aarebrot & Bakka 1997; De Meur & Rihoux 2002; De Meur, Rihoux & Ragin forthcoming). The vast majority of applications consider between 3 and 9 conditions (modal number: 4 to 6 conditions). Hence, models elaborated for QCA analysis tend to be parsimonious. Some less parsimonious models are to be found, however—for instance, with 12 conditions (Herala 2004) or even 20 conditions (King & Woodside 2001).

Last, but not least, one particularly interesting development in QCA applications is the explicit combination of QCA-type analysis with other types of analysis, both qualitative and quantitative. Most often, there is already a great deal of "upstream" qualitative work involved in the process of achieving an in-depth understanding of cases (Rihoux 2003; Ragin 2004b). Hence our focus here is more on the combination of QCA with other formal—mainly quantitative—methods. A first strand of attempts builds bridges between QCA and process-oriented formal techniques, such as Event Structure Analysis (Bruegemann & Boswell 1998), strategic narratives (Stevenson & Greenberg 2000), game modeling (Boswell & Brown 1999), and social network analysis (Stevenson & Greenberg 2000). On the other hand, several fruitful attempts have been made to confront QCA with some more or less mainstream quantitative techniques: discriminant analysis (Berg-Schlosser & De Meur 1997; Berg-Schlosser forthcoming), factor analysis (Berg-Schlosser forthcoming), various types of multiple regression (Amenta & Poulsen 1996; Ebbinghaus & Visser 1998; Kittel et al. 2000; Nelson 2004), logistic regression (Amoroso & Ragin 1992; Ragin & Bradshaw 1991), and logit regression (Heikkila 2001; Dumont & Bäck forthcoming). We should also mention explicit combinations of QCA with fuzzy sets and/or with multi-value QCA (e.g., Berg-Schlosser forthcoming; Nelson 2004).

In a nutshell: the field of QCA and QCA-related applications is evolving rapidly, with many ongoing projects, including some in-depth endeavors by Ph.D. students in several disciplines. There is still a lot of room for refinement and innovation. At the same time, it is encouraging to see that—probably as a result of the technique becoming more extensively documented and taught—the most recent QCA applications tend to follow some basic rules of "good practices."

Best QCA Practices I: General Guidelines

QCA is still a methodological newcomer; hence, it is important to formulate, out of experience and observation of existing applications, some guidelines regarding "best practices."[10] To start with, some *general* guidelines can be stated.

First, one should make a "reasonable" use of QCA. The technique can be used for at least five different purposes (De Meur & Rihoux 2002; De Meur, Rihoux & Ragin forthcoming). QCA may first be used in a straightforward manner simply to *summarize data in the form of a truth table*—in other words, as a tool for data exploration. Second, the researcher may take advantage of QCA to *check the coherence* of his/her data, mainly through the detection of contradictions. Third, QCA can be used to *test hypotheses or existing theories*. A fourth use, quite close to the third, is the *quick test of any assumption* formulated by the researcher—that is, without testing a preexisting theory or model as a whole. This is another way of using QCA for data exploration. Last, but not least, QCA may be used in the process of *developing new theoretical assumptions* in the form of hypotheses, following a more inductive approach. The researcher should determine which uses of QCA best suit his/her research goals. Indeed, some of these five uses of QCA are still very much under-exploited.

Second, it is advisable to draw on the different functions of the software. Many of these functions are still under-used, such as the "hypothesis testing" function (Watanabe 2003, Yamasaki 2003), which can be exploited in different ways.

Third, technical and reference concepts should be used with precision, in order not to induce confusion in the reader. Several misunderstandings—and misplaced critiques of QCA—stem from the misuse of technical terms. One of the most frequent examples is the reference to "independent variables" (instead of "conditions," as potential explanatory factors are referred to in the language of QCA). The problem is that conditions are *not* "independent variables" in the statistical sense (Rihoux et al. 2004).

Fourth, one should never forget the fundamentally configurational logic of QCA (Ragin 2003b; 2004b; Nomiya 2004). Hence, one should never consider the influence of a condition in an isolated manner, especially in the interpretation of the solution of a truth table.

Fifth, QCA should never be used in a mechanical manner, but instead as a tool that requires iterative steps. With QCA, there are frequent moves back and forth between the QCA analysis proper (i.e., use of the software) and the cases, viewed in the light of theory. Bottom line: the use of QCA should be both case-informed (relying on "case-oriented knowledge"; Ragin 2003b) and theory-informed. When researchers encounter difficulties, they should not try to conceal them; instead, they should explain, as transparently as possible, how they have been resolved. This often implies being transparent about trade-offs, "pragmatic" choices which may at times seem somewhat arbitrary ("rules of thumb") in real-life research. But at least the reader is informed about the choices that have been made and their rationale.

Sixth, one should be careful in the interpretation of the solution of a truth table (reached at the end of the Boolean minimization procedure with QCA). In particular, it is advisable to be cautious before interpreting a truth table solution in terms of "causality." Technically speaking, such solutions express, more modestly, co-occurrences reflecting potential explicit connections. It is then up to researchers to decide (relying on their substantive and theoretical knowledge) how far they can go in the interpretation of the truth table solution in terms of causality.

Finally, in the research process, it is almost always fruitful to use different methods. No researcher should become a "QCA monomaniac"—indeed we would argue that the same is true for any other method, whether or not QCA is used. At different stages of research, it is often the case that different methods suit different needs. Thus it is advisable to use QCA in some stages of research, while exploiting other methods (qualitative or quantitative) at other stages of the research. This is not to say that QCA should necessarily be used in a "modest" way. Indeed, we believe that, in some research situations, QCA should be used as the main data analytic tool.

Best QCA Practices II: Technical Aspects and Procedure

In all QCA applications, at least when one strives to make a "full" use of QCA, there are three main phases: (1) constructing the truth table, based on accumulated case-level knowledge and theoretical knowledge, (2) analyzing the truth table (the "analytic moment"), and (3) taking the results back to the cases and theory to evaluate findings. Questions illustrating the third phase might include: Do the results illuminate new things about the cases? How do they confront existing theories? Following this typical QCA application process, some more precise technical and procedural pieces of advice may be offered:[11]

1. Select cases in a rigorous manner. The way cases are selected—the comparative research design—should be stated explicitly.

2. To the extent possible, develop an "intimacy" with each case, to gain a deep, "thick" understanding.

3. Select the condition variables in a rigorous fashion—in a theoretically and empirically informed way. Do not select too many conditions. It is best to focus on conditions that seem decisive from the perspective of either substantive or theoretical knowledge.

4. When the raw data is quantitative (for example, interval-scale data) and the *N* is not too large, display the data in tables so colleagues can test other operationalizations of your conditions.

5. When using conventional (crisp) sets, explain clearly how each condition is dichotomized. Justify the placement of the 0/1 threshold on empirical and/or theoretical grounds. Use technical criteria (e.g., the mean or the median) only as a last resort. When constructing fuzzy sets, carefully calibrate membership scores using theoretical and substantive knowledge. Pay close attention to the meaning of the label attached to the set (see Ragin 2000; 2004a).

6. If possible, display the truth table and indicate which observed cases correspond to each combination of conditions.

7. If the truth table contains contradictory configurations, resolve them. There are several ways to do this (De Meur & Rihoux 2002; De Meur, Rihoux & Ragin forthcoming).

8. Proceed systematically to four analyses: those for the configurations with a positive outcome (coded 1 for present), first without and then with the inclusion of remainders (i.e., combinations of conditions lacking cases); and then analyze the configurations with a negative outcome (coded 0 for absent), first without and then with the inclusion of remainders. In order to do so, quite naturally, cases with a "0" outcome and cases with a "1" outcome should be included in the research. If the analysis embraces only positive cases, then only one analysis is possible—the analysis of cases coded 1 on the outcome, with remainders defined as negative cases (false).

9. The analysis should be done with software using the Quine-McCluskey algorithm and not by hand.

10. Resolve any "contradictory simplifying assumptions" that may have been generated in the process of minimization with the inclusion of remainders.[12]

11. Provide some information (even in a shorthand manner) about the main iterations of the research (back to cases, back to theories, fine-tuning of the model, etc.).

12. At the end of each truth table analysis, report all combinations of conditions linked to the outcome (i.e., the full solution of the truth table). If one or some subset of these combinations is eventually selected as being more relevant or important, justify this choice.

13. Proceed to a real "return to the cases" (and/or theory, depending on research goals) at the end of the analysis, using the truth table solution as a guide.

Needless to say, there is no *perfect* QCA analysis. In real-life research, some of these best practices are not easy to implement, and indeed they can be time-consuming (especially "case intimacy").

Best QCA Practices III: "Remainders" and Counterfactual Analysis

One of the most interesting—and powerful—features of QCA is its explicit consideration of unobserved combinations of causal conditions (remainders). This aspect of QCA is also subject to some (mostly misplaced) critiques (Markoff 1990; Romme 1995; see De Meur & Rihoux 2002; De Meur, Rihoux & Ragin forthcoming). Thus, a detailed discussion of this aspect of QCA is warranted.

A central characteristic of comparative research, and qualitative research in general, is the simple fact that researchers work with relatively small Ns. Investigators often confront more variables than cases, a situation that is greatly complicated by the fact that comparativists typically focus on *combinations* of case aspects—how aspects of cases fit together configurationally. For example, a researcher interested in a causal argument specifying an intersection of four conditions ideally should consider all sixteen logically possible combinations of these four conditions in order to provide a thorough assessment of this argument. Naturally occurring phenomena, however, are profoundly limited in their diversity. The empirical world almost never presents social scientists all the logically possible combinations of causal conditions relevant to their arguments (as shown with hypothetical data in Table 2, above). While limited diversity is central to the constitution of social and political phenomena, it also severely complicates their analysis.

As a substitute for absent combinations of causal conditions, comparative researchers often engage in "thought experiments" (Weber [1905] 1949). That is, they imagine counterfactual cases and hypothesize their outcomes, using their theoretical and substantive knowledge to guide their assessments. Because QCA uses truth tables to assess cross-case patterns, this process of considering counterfactual cases (i.e., combinations of causal conditions lacking cases) is explicit and systematic. In fact, this feature of QCA is one of its key strengths. However, the explicit consideration of counterfactual cases and the systematic incorporation of the results of such assessments into statements about cross-case patterns is relatively new to social science. The specification of best practices with respect to QCA and counterfactual analysis, therefore, is essential. We begin our discussion of best practices with the description of two techniques for addressing the "limited diversity" of combinations of causal conditions in QCA.

Limited diversity can be seen in the rows of the truth table shown in Table 2 that lack cases. The solution to a truth table depends in part on how these remainder rows are treated. The most conservative strategy is to treat them as instances of the absence of the outcome when assessing the conditions for the presence of the outcome, and to treat them as instances of the outcome when assessing the conditions for its absence. Doing so yields the following solutions to the truth table (Table 2):

presence of the outcome:

$$A \cdot B \cdot c \rightarrow Y$$

absence of the outcome

$$a \cdot c \cdot d + a \cdot B \cdot D \rightarrow y$$

In these equations, uppercase letters indicate the presence of a condition; lowercase letters indicate its absence; A, B, C, and D are causal conditions; Y is the outcome; multiplication (·) indicates combined conditions (intersection); addition (+) indicates alternate combinations of conditions (union), and "→" indicates an explicit connection. The equation for the presence of the outcome states simply that there is a single combination of conditions explicitly linked to Y, the presence of A and B combined with the absence of C (A·B·c). The equation for the absence of the outcome states that there are two combinations of conditions linked to the absence of Y: (1) the combined absence of A, C, and D (a·c·d), and (2) the absence of A combined with the presence of B and D (a·B·D).

In QCA, an alternate strategy is to treat remainders as *don't care* combinations (the *don't care* label reflects the origin of truth table analysis in the design of switching circuits). When treated as a *don't care*, a remainder is available as a potential simplifying assumption. That is, it will be treated as an instance of the outcome if doing so results in a logically simpler solution. Likewise, it also can be treated as an instance of the absence of the outcome, again, if doing so results in a logically simpler solution for the absence of the outcome. Using the remainder terms in Table 2 as *don't cares* yields the following solutions:

presence of the outcome:

$$A \rightarrow Y$$

absence of the outcome:

$$a \rightarrow y$$

Obviously, the solutions incorporating *don't care* combinations are remarkably parsimonious, but are they plausible? Before addressing this question, it is important to point out that given the evidence in Table 2, a conventional quantitative analysis of these data would quickly lead to the identification of condition A as the proper explanation of outcome Y. After all, as the table shows, whenever A is present, Y is present; whenever A is absent, Y is absent. None of the other causal conditions displays this simple relationship. Thus, the QCA solution incorporating *don't care* combinations dovetails with the results of a conventional quantitative analysis of the same data.

The plausibility of this solution, however, depends upon the results of the researcher's counterfactual analysis. Consider the analysis of the presence of outcome Y. Without incorporating *don't care* combinations, the solution is A·B·c; with *don't care* combinations, it is A. It follows that six *don't care* combinations have been incorporated into the parsimonious solution: A·b·c·d, A·b·c·D, A·b·C·d, A·b·C·D, A·B·C·d, and A·B·C·D. In essence, the conclusion that A is the sole cause of Y, based on the analysis framed by the truth table, assumes that if any of these six combinations of conditions could be found, they would also display the outcome (Y).[13] In other words, the analysis of six counterfactual cases undergirds the conclusion that A by itself causes Y, which is a dramatic use of simplifying assumptions. For this reason, it is common in presentations of QCA to emphasize the fact that researchers must evaluate any "remainders" incorporated as "simplifying assumptions" into the solution of a truth table. This admonition is equivalent to advising QCA researchers to conduct all the requisite counterfactual analyses. (Notice that no comparable admonition would follow from a conventional quantitative analysis of these same data.)

Too often researchers bypass counterfactual analyses because these assessments are tedious and time consuming. Instead, they embrace parsimony and automatically use all the simplifying assumptions incorporated into the most parsimonious solution they can produce. This unfortunate practice duplicates many of the foibles of conventional quantitative analysis. At first glance, the task of evaluating counterfactual cases may seem daunting. However, once it is recognized that theoretical and substantive knowledge make some counterfactuals "easy," this task is greatly simplified. Further, as we show, the incorporation of "easy" counterfactuals into a solution is straightforward and does not require line-by-line assessment of all the remainders reported in the truth table.

Imagine a researcher who postulates, based on existing theory, that causal conditions A, B, C, and D are all linked in some way to outcome Y. That is, it is the presence of these conditions, not their absence, that should be linked to the presence of the outcome. Suppose the empirical evidence revealed that many instances of Y are coupled with the presence of causal conditions A, B, and C, along with the *absence* of condition D (i.e., A·B·C·d $\rightarrow$ Y).[14] The researcher suspects, however, that all that really matters is having the first three causes, A, B, and C. In other words, for A·B·C to generate Y, it is not necessary for D to be absent. However, there are no observed instances of A, B, and C combined with the presence of D (i.e., there are no empirical instances of A·B·C·D). Thus, the decisive case for determining whether the *absence* of D is an essential part of the causal mix (with A·B·C) simply does not exist.

Through counterfactual analysis (i.e., a thought experiment), the researcher could declare this hypothetical combination (A·B·C·D) to be a likely instance of the outcome (Y). That is, the researcher might assert that A·B·C·D, if it existed, would lead to Y. This counterfactual analysis would allow the following logical simplification:

$$A{\cdot}B{\cdot}C{\cdot}d + A{\cdot}B{\cdot}C{\cdot}D \rightarrow Y$$
$$A{\cdot}B{\cdot}C{\cdot}(d + D) \rightarrow Y$$
$$A{\cdot}B{\cdot}C \rightarrow Y$$

How plausible is this simplification? The answer to this question depends on the state of the relevant theoretical and substantive knowledge concerning the connection between D and Y in the presence of the other three causal conditions (A·B·C). If the researcher can establish, on the basis of existing knowledge, that there is every reason to expect that the presence of D should contribute to outcome Y under these conditions (or conversely, that the absence of D should not be a necessary contributing factor), then the counterfactual analysis just presented is plausible. In other words, existing knowledge makes the assertion A·B·C·D $\rightarrow$ Y an "easy" counterfactual, because it involves the addition of a redundant contributing condition (D) to a configuration which is believed to be linked to the outcome (A·B·C).

It is important to point out that what has been accomplished using Boolean algebra in this simple example is routine, though often implicit, in much case-oriented research. If conventional case-oriented researchers were to examine the empirical instance just listed (A·B·C·d $\rightarrow$ Y), they would likely develop their causal argument or narrative based on factors thought to be linked to the outcome (that is, the presence of A, B, and C). Along the way, they *might* consider the possibility that the absence of D observed in these cases might be connected in some way to the production of Y by A·B·C. They would be quite likely to conclude otherwise, given the presumed state of existing knowledge about the four causal conditions relevant to outcome Y, namely that it is the presence of these causal factors, not their absence, that is linked to the outcome. Thus, they would quickly arrive at the more parsimonious conclusion, A·B·C→ Y. The point is that counterfactual analysis is not always explicit or elaborate in case-oriented research, especially when the counterfactuals are "easy." Such analyses are routinely conducted by case-oriented researchers "on the fly"—in the process of constructing explanations of a specific case or category of cases.

The incorporation of easy counterfactuals in QCA is straightforward. As just noted, researchers using QCA have two main options when confronted with limited diversity and thus potential counterfactual cases: (1) They can avoid using any remainders to simplify a truth table, or (2) they can permit the incorporation of the subset of remainders that yields the most parsimonious solution of the truth table. The first option bars counterfactual cases altogether; the second permits the inclusion of both easy and difficult counterfactuals, without any evaluation of their plausibility. At first glance, neither of these options seems attractive. The first is likely to lead to results that are needlessly complex; the second may lead to results that are unrealistically parsimonious due to the incorporation of "difficult" counterfactuals. It is useful to view these two "options" as endpoints of a single continuum of possible results. One end of the continuum privileges complexity; the other end privileges parsimony.[15] Both endpoints are rooted in evidence; they differ in their tolerance for the incorporation of counterfactual cases.

One strength of QCA is that it not only provides tools for deriving the two endpoints of the complexity/parsimony continuum, it also provides tools for specifying intermediate solutions. Consider again the truth table presented in Table 2, which uses A, B, C, and D as causal conditions and Y as the outcome. Assume, as before, that existing theoretical and substantive knowledge maintains that it is the presence of these causal conditions, not their absence, that is linked to the outcome. The results of the analysis barring counterfactuals reveal that combination A·B·c explains Y. The analysis of this same evidence permitting any counterfactual that will yield a more parsimonious result is that A by itself accounts for the presence of Y. Conceive of these two results as the two endpoints of the complexity/parsimony continuum, as follows:

A·B·c	A
complexity	parsimony

Observe that the solution privileging complexity (A·B·c) is a subset of the solution privileging parsimony (A). This follows logically from the fact that both solutions must cover the rows of the truth table with Y present; the parsimonious solution also incorporates some of the remainders as counterfactual cases and thus embraces additional rows. Along the complexity/parsimony continuum are other possible solutions to this same truth table, for example, the combination A·B. These intermediate solutions are produced when different subsets of the remainders used to produce the parsimonious solution are incorporated into the results. These intermediate solutions constitute subsets of the most parsimonious solution (A in this example) and supersets of the solution allowing maximum complexity (A·B·c). The subset relation between solutions is maintained along the complexity/parsimony continuum. The implication is that any causal combination that uses at least some of the causal conditions specified in the complex solution (A·B·c) is a valid solution of the truth table as long as it contains all the causal conditions specified in the parsimonious solution (A). It follows that there are two valid intermediate solutions to the truth table:

	A·B	
A·B·c	A·c	A
complexity		parsimony

Both intermediate solutions (A·B) and (A·c) are subsets of the solution privileging parsimony and supersets of the solution privileging complexity. The first (A·B) permits counterfactuals A·B·C·D and A·B·C·d as combinations linked to outcome Y. The second permits counterfactuals A·b·c·D and A·b·c·d.

The relative viability of these two intermediate solutions depends on the plausibility of the counterfactuals that have been incorporated into them. The counterfactuals incorporated into the first intermediate solution are "easy" because they are used to eliminate c from the combination A·B·c, and in this example, existing knowledge supports the idea that it is the *presence* of C, not its absence, that is linked to outcome Y. The counterfactuals incorporated into the second intermediate solution, however, are "difficult" because they are used to eliminate B from A·B·c. According to existing knowledge, the presence of B should be linked to the presence of outcome Y. The principle that only easy counterfactuals should be incorporated supports the selection of A·B as the optimal intermediate solution. This solution is the same as the one that a conventional case-oriented researcher would derive from this evidence, based on a straightforward interest in combinations of causal conditions that are (1) shared by the positive cases (or at least a subset of the positive cases), (2) believed to be linked to the outcome, and (3) not displayed by negative cases.

As our example illustrates, incorporating different counterfactuals yields different solutions. However, these different solutions are all supersets of the solution privileging complexity and subsets of the solution privileging parsimony. Further, we have shown that it is possible to derive an optimal intermediate solution permitting only "easy" counterfactuals. This solution is relatively simple to specify. The researcher removes causal conditions from the complex solution that are inconsistent with existing knowledge, while upholding the subset principle that underlies the complexity/parsimony continuum: any intermediate solution constructed by the researcher must be a subset of the most parsimonious solution. The counterfactuals that are incorporated into this optimal solution would be relatively routine in a conventional case-oriented investigation of the same evidence.

One of the great strengths of QCA is that all counterfactuals, both easy and difficult, are made explicit, as is the process of incorporating them into results. QCA makes this process transparent and thus open to evaluation by the producers and consumers of social research.

Future Prospects

In many ways, set-theoretic methods are still in their infancy in the social sciences today. QCA and fs/QCA are both works in progress, with new advances and refinements being made every year. However, there is now a critical mass of researchers in Europe, North America, and Japan using and refining set-theoretic methods. QCA has been advanced primarily through applications by comparative researchers as they confront foundational issues in social science methodology in the midst of conducting what they thought would be straightforward substantive research. While the approach is still developing and maturing, it is possible to sketch several promising prospects. These include: (1) further developing QCA-related software, (2) using QCA to support and advance collaborative research using middle-range Ns, (3) applying QCA to policy questions, and (4) transporting some of the methodological advances implemented in QCA to the analysis of large-N data sets.

Software development. At present, two promising developments are underway, aside from the regular updating of the "standard" (i.e., crisp, dichotomous) software modules and interface. The first one is the development of the fuzzy-set approach, already available in the fs/QCA software. The second one is the "extension" of QCA into MVQCA (through the TOSMANA software). MVQCA applies "crisp" logic to categorical data with more than 2 categories. Another challenge lying ahead will be to find ways to inject the time dimension (i.e., a dynamic perspective) *within* QCA-related software.

Collaborative research. QCA's greatest strength is the analysis of intermediateNs. By *intermediate* we mean more than a handful but too few for sophisticated statistical analysis (e.g., an N in the range of 5-100). In-depth analysis of many cases by a single researcher is quite difficult. However, QCA works best when used in conjunction with in-depth case knowledge. For these reasons, an especially promising use of QCA is in collaborative research involving scholars with different case expertise. This collaboration can extend to all phases of the research process, from developing analytic frames which might serve as the basis for truth tables, to the application of the results of QCA to specific cases. The key to the collaboration is the development of a common framework, which can be implemented through truth tables. A few of these collaborative research efforts are currently underway.

Policy research. The concerns of policy researchers sometimes diverge from those of academic researchers. For example, policy researchers, especially those concerned with social as opposed to economic policy, are often more interested in different kinds of cases and their different fates than they are in the estimation of the net causal effect of independent variables across a large, encompassing population of observations. After all, a common goal of social policy is to make decisive interventions, not to move average levels or rates up or down by some small fraction. Interventions are most feasible when connections are explicit, not tendential, as described in this paper. That is, a particular policy is most capable of decisive intervention when it is grounded in explicit case-oriented knowledge addressing specific categories of cases. QCA is especially well-suited to the generation and accumulation of this type of policy-oriented knowledge. A particularly promising sub-field for QCA applications in this respect is *policy evaluation*, both *ex post* and *ex ante* (De Meur, Varone & Rihoux 2004).

Large-N research. QCA departs fundamentally from the linear models that undergird most quantitative research in the social sciences today. It attends to configurations of case aspects; it seeks to specify complex conjunctural causation; and it addresses the issue of limited diversity by directly considering combinations of conditions that lack cases. In these respects, QCA challenges the mainstream of quantitative social science. Some of the techniques implemented in QCA can be transported directly to large-N investigations. After all, there is no procedural limit *per se* on the number of cases researchers can study using QCA.

For example, limited diversity is not limited to small- and intermediate-N investigations. That is, it is not a problem that exists simply because there are "not enough cases" to populate all the sectors of the vector space defined by the independent variables. Rather, limited diversity is inherent in the constitution of social and political phenomena. Ragin (2003a), for example, demonstrates that a large-N, individual-level data set (N = 758) populates only 24 rows of a 32-row truth table (five causal conditions), and that 13 of these 32 rows contain almost all the cases (96.7% of the total N). In an analysis of individual-level data on musical tastes (N = 1,606), Sonnett (2004) similarly finds that 22 of 64 rows in the truth table (34% of the rows) contain the bulk of the respondents in the sample (90%). Braumoeller (2003: 229) finds abundant evidence of "complex covariation" in a data set with 8,328 observations. Almost any analysis that investigates combinatorial complexity in naturally occurring phenomena will confront an abundance of combinations of causal conditions without cases and thus many potential counterfactual cases. QCA provides a blueprint for confronting these vacancies in the vector space with theoretical and substantive knowledge and thereby avoiding the homogenizing assumptions (e.g., linearity and additivity, to mention the two best-known assumptions) that quantitative researchers usually fall back on.

In conclusion, much remains to be done in this field. There is plenty of innovative work lying ahead, both in terms of methodological/epistemological reflection, further improvement of tools (software in particular), inventive exploitation of these tools, and use of QCA-related techniques in more "academic" as well as more "applied" (in particular policy-oriented) research.

Endnotes

[1] With the support of the *Fonds National de la Recherche Scientifique – FNRS* (Belgium).

[2] Hereafter, *QCA* is used generically to refer to both QCA and fsQCA, as well as to the multi-value QCA (MVQCA) variant; see the "Software" section of http://www.compasss.org and Cronqvist (2004).

[3] Practical descriptions of the technique are presented in De Meur and Rihoux (2002) and in De Meur, Rihoux, and Ragin (forthcoming).

[4] The term *causal condition* or *condition* is used generically in this paper to refer to an aspect of a case that is relevant in some way to the researcher's account or explanation of some *outcome* exhibited by the case.

[5] It is important to point out that neither strategy expects nor depends on perfect set-theoretic relations. For example, if *almost all* (as opposed to *all*) instances of democratic consolidation involved presidential systems, then the researcher would no doubt accept this as evidence of an explicit connection between presidentialism and democratic consolidation. Specific procedures for probabilistic assessment of set-theoretic patterns using benchmarks are presented in Ragin (2000).

[6] We use *correlation* generically here to refer to the examination of the strength of the association between two variables, and not as a specific reference to Pearson's *r* or to the specific calculations used to produce Pearson's *r*.

[7] It is important to point out that the procedures described here are *not* dependent on the use of dichotomies. Truth tables can be built from fuzzy sets (with set memberships in the interval from 0 to 1) *without* dichotomizing the fuzzy scores. These procedures take full advantage of the graded membership scores central to the fuzzy-set approach (see Ragin 2000, 2004a; De Meur, Rihoux and Ragin, forthcoming).

[8] This section is restricted to "crisp," dichotomous QCA (i.e., does not include fuzzy sets or MVQCA). The compilation of the data for this section has been made by Sakura Yamasaki and Sophie Ronsse (COMPASSS, UCL).

[9] A comprehensive list of applications is available through the COMPASSS International bibliographical database: http://www.compasss.org/Bibli%20database.htm.

[10] This section draws on (and extends) some material to be found on the "didactics" page of the COMPASSS resource site (Rihoux et.al. 2003).

[11] This discussion draws on and extends the didactics page of the COMPASSS website. For a discussion of fuzzy-set procedures, see Ragin (2000; 2004a).

[12] Several ways to tackle such "contradictory simplifying assumptions" are presented in a recent issue of the *Revue Internationale de Politique Comparée* (Clément 2004, Grassi 2004, Vanderborght & Yamasaki 2004). See also Rihoux (2001).

[13] Of course, if a "found" combination were to disconfirm the assumptions behind the solution (A causes Y), then it would be incumbent upon the researcher to explain the inconsistency, based on in-depth analysis of the found case(s) displaying the combination in question.

[14] There can be other, unspecified combinations of causal conditions linked to outcome Y in this example. There is no assumption that this is the only combination linked to the outcome (Y).

[15] For an argument in defense of this "most parsimonious" option, see De Meur & Rihoux (2002) and Rihoux et.al. (2004).

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Comments on the Use and Utility of QCA

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One has to respect and admire Charles C. Ragin, Benoît Rihoux and their associates for pursuing an ambitious and worthy task through the years, namely crossing the chasm between purely qualitative research procedures and big-N quantitative studies. Specifically, they propose a set of methods for dealing with an intermediate number of cases (an example might be a study of 20 countries). Despite their claims (both earlier and present), I am sorry to report that I find the results to be disappointing to the point where I would question its basic utility for solving the problem that it addresses. I will not detail those objections that appear in a careful review essay of Ragin's *Fuzzy-Set Social Science* (Lieberson, 2001). Among other matters, there are virtually no data-based comparisons between their proposed procedures and current practices; polemics yes, but no evidence that the proposed methods supplant existing practices. In this essay, I will emphasize several fundamental problems by proposing three hypotheses that should enable us to evaluate QCA—particularly its disturbing use of deterministic ways of thinking in situations for which there is no justification. My hypotheses do not require acceptance of my position, since they imply some distressful features of QCA that can be studied empirically. Hence, the reader unwilling to give up on QCA is in a position to evaluate it.

A crucial assumption in QCA is that the data cross-tabulations reflect a set of deterministic causes. Ragin and associates may not concede this, but the denial cannot pass the quack test—if it sounds like a duck, etc. The method does not allow for a condition in which a given cause increases or decreases the likelihood of some outcome—but not always. Rather, if the outcome in question is sometimes associated with the presence of a given causal variable, but not always, then Ragin and associates will look for additional variables such that a set of interaction effects is eventually found to account for all the observed connections. In other words, when QCA is finished, all conditions are accounted for. For example, the presence or absence of the dependent variable is fully explained in all, say, 20 countries examined. But is this reasonable? Yes and no. It is reasonable in the sense that this could be the case after they throw into the pot combinations of "necessary, insufficient, and sufficient." And, indeed, by the time they finish we have an explanation of every single case—in which the dependent variable appears or does not appear. You might well wonder: How could this be bad? For several reasons, what appears to be so wonderful is really not wonderful and, indeed, is apt to be misleading. It generates a plausible account of the observed data, but hardly the only plausible account that one could generate. "OK," you might want to say, "this is the story for social science in general. What's so special about this?" The answer is that we are no closer to knowing anything than before we started. First of all, a fan of QCA might become a little suspicious when he/she thinks about the fact that QCA is less prepared to allow for chance and probabilistic processes than is the case in many of the hard sciences. That ought to make us stop and wonder. If we are operating in a probabilistic universe, and if we recognize that there are errors in data and that almost surely the comparisons involve influences that are not comparable or necessarily or always measurable (even if imperfectly), then it is bothersome that the data table provided in QCA cannot ascertain whether the observed pattern includes a stiff dose of random results and leads to massive over-interpretation. Indeed the procedures do not rule out the possibility that the observations are all a random matter and/or that none of the causal variables were even measured. Everything gets explained, but never through any variable that simply increases or decreases the chances of an outcome. In QCA, added variables are brought in to generate interaction effects so as to explain why a given variable appears to have one effect in