Opposites Attract? Opportunities and Challenges for Integrating Large-*N* QCA and Econometric Analysis

Peer C. Fiss[1], Dmitry Sharapov[2], and Lasse Cronqvist[3]

DOI: 10.1177/1065912912468269e

Abstract

Contrasting insights that can be gained from large-N QCA and econometric analysis, we outline two novel ways to integrate both modes of inquiry. The first introduces QCA solutions into a regression model, while the second draws on recent work in lattice theory to integrate a QCA approach with a regression framework. These approaches allow researchers to test QCA solutions for robustness, address concerns regarding possible omitted variables, establish effect sizes, and test whether causal conditions are complements or substitutes, suggesting that an important way forward for set-theoretic analysis lies in an increased dialogue that explores complementarities with existing econometric approaches.

Introduction

In its original statement by Charles Ragin (1987), Qualitative Comparative Analysis (QCA) was conceived as a methodology for small-*N*, comparative work in the case-oriented tradition; a conception that still resonates with much of the current work using QCA (Rihoux and Ragin 2009). However, researchers have also applied QCA to examine large-*N* phenomena (e.g., Fiss 2011; Greckhamer, Misangyi, Elms, and Lacey 2008; Ragin and Fiss 2008; Vis 2012).[1] These large-*N* applications have prompted Greckhamer, Misangyi, and Fiss (forthcoming) to suggest that currently there are in fact "two QCAs" that differ in their focus on small- and large-*N* phenomena as well as in some of their assumptions, objectives, and analyses processes.

Several issues are raised by applying QCA to a larger number of cases. In particular, researchers applying this approach find themselves largely on the same research terrain as traditional large-*N* researchers using econometric tools usually based on the standard linear model. We believe that this has proven to be both an opportunity and a challenge. On the positive side, the application of QCA to large-*N* situations offers a considerable opportunity for both new empirical insights and new theory building. For instance, prior works that focus on hypothesis testing in particular have tended to develop theories based on correlational statements. As Ragin (2000, 2008) has argued, such thinking does not necessarily correspond to the nature of causal relations present in social research. Accordingly, the introduction of QCA to a whole new series of phenomena carries a significant upside. However, this upside does not come without challenges. Chief among these is that in large-*N* QCA, it is difficult to maintain the kind of intimate familiarity with the cases that small-*N* QCA is usually based on. As a result, measurement errors in coding of cases are more likely. Contradictory observations in large-*N* QCA might then at times be accepted as measurement error, whereas in small-*N* QCA, they will frequently trigger a re-examination of the cases selected and whether all relevant causal conditions have been included. Due to this, establishing the robustness of QCA results is a more important concern in large-*N* applications than it is in small-*N* ones. In this article, we argue that there are two aspects in particular that need to be addressed for QCA to achieve its full potential as a method covering both small-*N* and large-*N* situations.

The first issue relates to distinguishing the unique contribution of QCA relative to existing econometric tools when both could be used in large-*N* situations. To help realize QCA's potential as a tool for large-*N* analysis, we briefly contrast large-*N* QCA with standard econometric approaches. This discussion is intended to lay the

[1]University of Southern California, Los Angeles, USA
[2]University of Cambridge, UK
[3]University of Trier, Germany

groundwork for the second issue, which focuses on potential synergies and ways to integrate the insights from QCA with other econometric tools. Specifically, we suggest that integrating QCA findings into a regression framework or a lattice-theoretic analysis that draws on recent work in lattice theory (Milgrom and Roberts 1990, 1995; Mohnen and Röller 2005) to mimic a QCA approach within a regression framework potentially allows for added insights regarding result robustness, effect sizes, complementarity and substitutability relationships between causal conditions, and the addition of causal conditions that otherwise would make a QCA too unwieldy. We conclude by suggesting that one way forward for set-theoretic analysis lies in an increased dialogue with existing econometric approaches.

Contrasting Approaches: Large-*N* QCA versus Correlation-Based Approaches

There is no question that QCA and correlation-based approaches such as linear regression are rather different beasts. As Ragin has argued, QCA should first and foremost be seen as a research strategy that emphasizes the dialogue of ideas and evidence, not merely a technique of analyzing data. But differences do not end there "set-theoretic relations concern *explicit* connections, while correlations address *tendential* connections; set-theoretic relations are *asymmetrical*, while correlations are *symmetrical*; set-theoretic relations are well suited for questions about necessity and sufficiency, while correlations are not; and so on" (Ragin 2005, 37; emphasis in original, see also Achen 2005 and Seawright 2005 for alternative views). Along similar lines, Vis (2012) argues that while regression analysis strives to explain the average effects of certain variables (causes), QCA seeks to identify the causes of particular outcomes (effects).

The contrasts between both approaches thus stand in fairly clear relief; however, there are also considerable similarities. As Greckhamer et al. (forthcoming) argue, large-*N* QCA is in fact well suited to hypothesis testing and deductive reasoning and by its very nature maintains a distance between the researcher and the cases, thus making large-*N* QCA applications in fact similar to conventional econometric approaches even as such QCA applications retain their configurational nature. Vis (2012), likewise, proposes that fuzzy-set QCA (fsQCA) moves toward identifying the effects of (multiple) causes rather than the causes of effects as the number of cases under study increases. To clarify this relationship, we contrast large-*N* QCA with standard econometric correlation-based approaches regarding their estimation procedures and their measures of model fit, with a focus on beginning a deeper engagement between these two approaches that are based on rather different epistemological and methodological assumptions.

Contrasting Estimation Procedures

QCA is a means of analyzing multiple cases to identify "recipes" of causal conditions associated with case membership in an outcome set (Ragin 2008). This approach allows for equifinality (different configurations leading to the same outcome), asymmetric causality (absence of causal conditions associated with an outcome not leading to absence of the outcome), and for differentiating between causally core and causally peripheral conditions (causally core conditions are part of both parsimonious and intermediate solutions, whereas causally peripheral conditions are part of the intermediate solution but are eliminated in the parsimonious one) (Fiss 2011; Ragin 2000, 2008). In contrast, most basic econometric models are premised on what Ragin has termed "net effects thinking," that is they estimate the impact of individual explanatory variables on a dependent variable, holding everything else constant. Such models implicitly assume unifinality, as the maximum value of the dependent variable is achieved by maximizing all explanatory variables that have positive coefficients, and symmetric causality, as the effect of a reduction in an explanatory variable on the outcome is equal and opposite to the effect of an increase of the same magnitude. Furthermore, many of these issues also apply to more advanced econometric approaches such as hierarchical linear models that aim to capture interactions across levels of analysis (e.g., Lacey and Fiss 2009).

Although approaches such as interaction effects, cluster analysis, or deviation score analysis in combination with regression aim to overcome some of the liabilities of regression in analyzing configurations, each of these approaches faces significant shortcomings for researchers concerned with configurational analysis (e.g., Fiss 2007, 2009). Interaction effects can be used to test asymmetric configurational hypotheses that correspond to notions of necessity and sufficiency in QCA (Clark, Gilligan, and Golder 2006), but their use tends to be limited to two-way or occasionally three-way effects as higher-order interactions are difficult to interpret and are likely to result in multicollinearity.

In response, a newer class of regression-based approaches to the study of causally complex phenomena that has found some favor among political scientists is the partial observability probit approach proposed in Braumoeller (2003) and extended in Gordon and Smith (2004, 2005). In essence, these regression-based approaches allow researchers to statistically test theories proposing multiple causal paths by modeling the underlying causal processes. The probability of occurrence of each causal factor is modeled as a function of a set of explanatory variables, and these probabilities are then multiplied together to get the overall probability that the event of interest will occur. Although these methods can usefully shed light on causal complexity in a variety of contexts, simulations have shown that the convergence, unbiasedness, and efficiency of the estimates that these methods produce is highly contingent both on the structure of the data used and on the accuracy of assumptions about the data generating process (Braumoeller and Kirpichevsky 2005; Gordon and Smith 2004, 2005).

Contrasting Measures of Fit

Because the search for multicausal explanations is constitutive to the QCA approach, the main goal of the basic crisp-set QCA (csQCA) approach is to identify causes (or combinations of causes) that are common for cases exhibiting a certain outcome and to distinguish these cases from cases with a different outcome (Ragin 1987). Originally, no measurements of fit were included in the csQCA method. However, this changed with the introduction of consistency and coverage by Ragin (2006b, 2008), which presented a move toward expressing the importance of solutions within QCA. Ragin defines consistency as "the degree to which the cases sharing a given combination of conditions . . . agree in displaying the outcome in question," whereas coverage assesses "the degree to which a cause or causal combination 'accounts for' instances of an outcome." (Ragin 2008, 44).

Although these measurements can, to some extent, be used to qualify results of a csQCA analysis, they take on a more central role in fsQCA, as consistency is used to identify a subset of combination that exceed a given consistency threshold before reducing these combinations to identify more parsimonious solutions (Ragin 2008). By including the degree of consistency into the analysis itself, fsQCA introduces a measurement of fit based on set theory into the logic of QCA. Given the plethora of fit measures currently available to the skilled econometrician, it is not possible for us here to provide an extensive comparison between these fit measures and QCA-based fit measures. Instead, we focus on some basic differences in the nature of how fit is conceived in QCA. In particular, it is important to note that fsQCA applies a different criterion to determine "fit" than standard econometric analysis. Whereas, for example, an ordinary least squares (OLS)–based linear regression assumes a linear and thus symmetric relationship between independent and dependent variable, this is not the case in fsQCA, which assumes an asymmetric model of causality; in fsQCA, cases with a high value on a sufficient condition will always display high values of the outcome, but the inverse

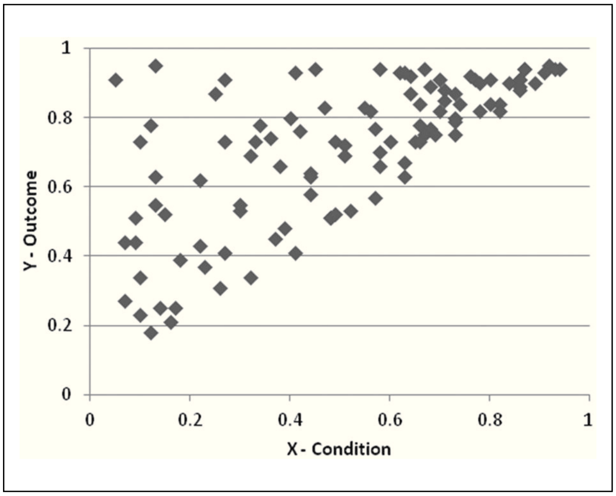

Figure 1. Relationship between condition and outcome fully consistent with sufficiency but with a low level of correlation in a regression analysis.

is not the case; in fact, cases with a low value on the condition may display both high *and* low values on the outcome. In situations of perfect consistency, all cases will show higher or equal values for the outcome than for the conditions considered. This means that, contrary to a linear regression, a high degree of consistency with sufficiency is present even if many cases show much higher values for the outcome than for the condition in consideration, as shown in Figure 1.

The fact that a data pattern such as the one shown in Figure 1 may be characterized by perfect consistency is a consequence of the multicausal notion of causality found in all varieties of QCA. In a linear regression, these cases would be assumed to contradict the underlying model, resulting in a low measurement of fit. In fsQCA, such cases showing a low value for the condition but a high value for the outcome indicate not so much "misfit" as they indicate an incomplete specification of the causal models; a different condition will have to be identified to account for the outcome in these cases.

Due to its ability to distinguish between necessary and sufficient conditions, fsQCA is able to offer the researcher a comprehensive analysis of the relationship between a causal condition and an outcome in question. In fsQCA, sufficient conditions must be differentiated from necessary conditions; whereas the degree of sufficiency of a condition indicates how far a condition can be related to the explanation of an outcome, the degree of necessity indicates how far a condition is necessary for an outcome to occur. Nonetheless, a data distribution showing a high measurement of fit in a regression analysis, as shown in Figure 2, will also show high levels of sufficiency as well as necessity with consistency in fsQCA.

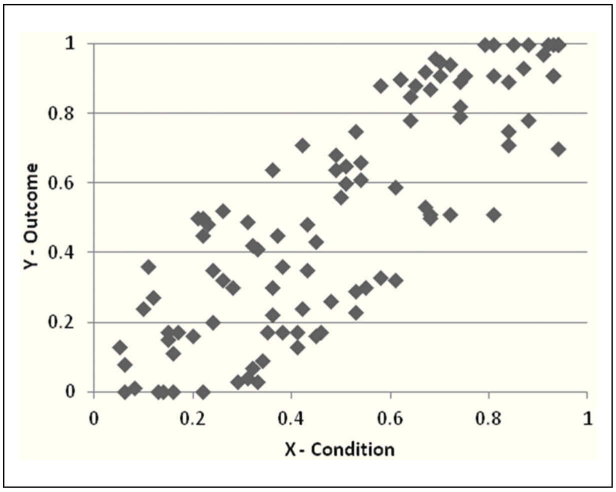

Figure 2. Relationship between causal condition and outcome highly consistent with both necessity and sufficiency (>0.9) and a high level of correlation in a linear regression.

Second, fsQCA offers a second measure of fit that assesses the coverage of a causal condition or a causal combination, thus providing an indicator of the scope of a causal condition in accounting for the outcome. This makes coverage comparable in spirit to coefficient of determination (R^2) that accounts for the proportion of variation in the outcome accounted for by the independent variables. However, it is again important to note that, unlike a correlation-based measure such as an R^2, coverage is an asymmetric measure. As such, coverage allows the researcher to assess how much of the variation in the outcome is accounted for by a causal condition. However, was the researcher to examine the inverse relationship—how much variation in the causal condition is accounted for by the outcome—a different value would be obtained.

Integrating Approaches: Opportunities for Complementary Insights

So far, we have focused on contrasting the insights generated using a QCA approach with those using more standard econometric methods. It seems evident that the two approaches are based on rather different philosophies regarding the spirit and nature of social science research; we nevertheless see considerable opportunities for not only using both approaches in a contrasting manner but to draw on both approaches in an integrative manner. This would involve going beyond triangulation involving data analysis based on either approach and comparing the results (e.g., Fiss 2011; Grofman and Schneider 2009), and going toward developing hybrid methods incorporating elements from both approaches. While a full discussion of such methods is beyond the scope of this article, we want to provide an outline of what such integrative methods might look like and what insights they might provide.

From the perspective of the large-*N* QCA researcher, there would appear to be at least two ways in which a regression-based approach might usefully be integrated with a set-theoretic approach.[2] The first one relates to the reintroduction of QCA solutions into a regression framework to test for robustness, establish effect sizes, and address concerns regarding omitted variables in the QCA. The second one takes a slightly different approach by drawing on recent work in lattice theory to mimic a QCA approach within a regression framework to test for complementarity or substitutability between causal conditions. We now address each of these in turn.

Using QCA Solutions in a Regression Framework

When used in a large-*N* setting, there are in fact several ways in which QCA allows the researcher to either explore or test hypotheses about configurations that are sufficient to bring about the outcome in question, such as examining the sufficiency of a given combination using inferential statistics (e.g., Ragin 2000) or examining whether the consistency of an overall solution obtained by a truth table analysis exceeds a specified threshold. In addition, the researcher has the option of evaluating the necessity of either individual conditions or combinations of conditions. However, one of the strengths of the QCA approach—making explicit that the construction of sets crucially affects the results obtained—is also one of its weaknesses in the sense that it is frequently difficult to obtain stable results. At times, apparently small changes in calibration or the choice of cut-off values regarding frequency and consistency thresholds can precipitate significant changes in the solutions obtained (Skaaning 2011). Although this is in principle no different from the situation faced in a correlational analysis, where transformation of variables, inclusion or exclusion of controls, or the choice of functional form can likewise have significant effects on the results found, it still raises the question of how robustness checks might be constructed to validate the solutions obtained in a QCA.[3]

One possible way to create an integrated approach involves entering the solutions obtained by a QCA into a regression analysis. For instance, assume for simplicity's sake that a fuzzy-set QCA has resulted in solution with two configurations that are sufficient to bring about the outcome: A•B•~C and A•~B•D. The researcher could then calculate the membership of each case in each configuration as the minimum across each of the three conditions involved, that is, min(A•B•~C) and min(A•~B•D), and save the resulting values as new variables. These new variables, which now stand for the configurations obtained, can then be used in a standard regression analysis to predict the outcome in question. If the correlation between these newly created variables is quite high and multicollinearity is thus a concern, the researcher could also choose to create an additional variable, which is the maximum across the two variables, following an approach commonly used in deviation score analysis that aims to assess overall fit (e.g., Doty et al. 1993). Alternatively, the researcher might create dummy variables coded 1 for cases that have membership scores ≥0.5 in the configuration and thus present good instances of that corner of the multidimensional property space. The advantage of that approach is that it creates a stronger contrast to cases that have lower membership in both the configuration and the outcome. Either way, a significant advantage of this approach is that the researcher can now estimate regression weights for paths obtained from a QCA and thus calculate the relative importance of each path. Because the outcome variable will normally also be a set and thus have restrictions in its range, a two-limit Tobit regression will usually be more appropriate than OLS regression when the dependent variable is truncated (Long 1997), as is the case with a fuzzy set.

The approach described here also has an additional advantage in that it allows the researcher to introduce further control variables into the analysis—a key challenge for the large-*N* QCA researcher who is unlikely to have the same familiarity with each case as the small-*N* QCA researcher, thus raising the issue of whether omitted causal conditions may in fact be driving the findings. Of course, in a traditional QCA, the notion of "controls" is usually not part of the analysis, as QCA does not consider isolating and estimating independent effects of causal variables as the central goal of analysis but instead focuses on combinations of causally relevant conditions (e.g., Ragin 2005). However, this approach comes at a cost, as the inclusion of each additional causal condition exponentially increases the number of configurations that need to be examined, with more than ten conditions making the analysis rather unwieldy. In contrast, incorporating solutions into a regression analysis would allow QCA researchers to examine whether the solutions identified also hold up when other relevant control variables are entered along with these solutions into a regression model.

The advantage of such a hybrid approach seems obvious, and we believe introducing such additional analyses would likely allow insights from large-*N* QCA to become more robust through comparison across methods and more precise in assessing the magnitude of relationships. Of course, there are also tradeoffs, as this kind of hybrid approach moves the analysis much further into the direction of causal homogeneity and additivity—a direction that the QCA approach was designed to avoid. In particular, incorporating paths into a regression analysis means results obtained from an analysis based on set membership are now examined in an analysis based on correlation. For paths that are consistent with a sufficient set relation but low coverage, the regression analysis may be unlikely to show a significant correlation. Accordingly, paths that are qualitatively important but empirically rare may not be picked up by such an analysis, a fact that the researcher would need to take into account in an interpretation of the results as a robustness check. However, when used in addition to rather than as a substitute for the set-theoretic analysis and with an eye toward understanding the inherent differences in emphasis between both methods, these tradeoffs seem acceptable for the pragmatic researcher aiming to get a fuller view of the patterns inherent in the data under analysis.

An Alternative Approach Based On Lattice Theory

The approach we have discussed so far uses the results from a QCA to create variables for usage in a regression analysis, thus aiming to exploit the ability of a set-theoretic analysis to deal with complex causality and identify configurations that can then be analyzed using analyses based on the general linear model. However, another potential way of integrating QCA with econometrics is based on the mathematics of optimization of functions on lattices (Milgrom and Roberts 1990, 1995; Topkis 1978).[4] Recently, this approach has been used to econometrically test for complementarity or substitutability between elements of a configuration by estimating the effects of configurations of binary explanatory variables on a dependent variable (Cassiman and Veugelers 2006; Mohnen and Röller 2005). Similarly to QCA, a lattice-theoretic approach allows for the identification of necessary and sufficient conditions, equifinality, asymmetric causality, and for identifying causally core elements of the configuration. Furthermore, the ability to test for complementarity between elements of the configuration may offer researchers a more fine-grained insight into what drives the association between configurations and outcomes, and may help direct theory-building efforts toward understanding the mechanisms through which such complementarities come about. Finally, this approach can be used to check the robustness of QCA results to the inclusion of numerous control variables that may affect the outcome but could not be included as causal conditions in QCA.[5]

The key feature of the lattice-theoretic approach for our purposes is its definition of complementarity between two activities. Suppose that an actor (such as a firm, a state, and a political party) engages in two activities, A and B, either or both of which it can choose to perform.

Accordingly, there are then four possible configurations of activities that the actor may end up choosing:

Configuration 1: neither A nor B (~A•~B)
Configuration 2: not A but B (~A•B)
Configuration 3: A, but not B (A•~B)
Configuration 4: both A and B (A•B)

A and B are complementary in an outcome function V(.) if V(A•B) − V(~A•B) > V(A•~B) − V(~A•~B). To restate, A and B are complementary if the return to performing activity A is greater if activity B is already being performed than if it is not. The above definition of complementarity also applies to set-theoretic logic if we take the consistency of solution membership in an outcome set *Y* as the outcome function V(.). Suppose that the configuration A•B is always a subset of the outcome of interest so its consistency is 100 percent, whereas the remaining three configurations are never subsets of the outcome with consistencies of 0 percent. Substituting these consistency values into the definition of complementarity given above we get: 100% (V(A•B))− 0% (V(~A•B)) > 0% (V(A•~B)) − 0% (V(~A•~B)). In this case, A and B are clearly complementary, but this is not particularly interesting as both A and B are necessary but insufficient conditions that must both be met to create the outcome.

To see that knowing more about complementarity (or substitutability) relationships than QCA results can uncover might be worthwhile, let us slightly alter the above example by giving the solution A•~B a consistency score of .80. Substitution gives: 100% (V(A•B)) − 0% (V(~A•B)) > 80% (V(A•~B)) − 0% (V(~A•~B)). Again, A and B are clearly complementary, but this case is more interesting than the first one because QCA (assuming a consistency cut-off ≤ .80 and no remainders) would produce a parsimonious solution A → *Y*, suggesting that B has no influence on the outcome. However, this is not the case as the choice of B when A has already been chosen has the rather substantial effect of increasing the consistency of the solution from 80 to 100 percent.

The lattice-theoretic approach has been used as the basis for econometric tests for complementarity in the field of innovation in the following manner (Mohnen and Röller 2005): First, a researcher runs the following regression analysis:

$$V = \beta_1(\sim A \bullet \sim B) + \beta_2(\sim A \bullet B) + \beta_3(A \bullet \sim B) + \beta_4(A \bullet B) + \gamma'\mathbf{Z} + \varepsilon,$$

where V is the dependent variable, (~A•~B) and other possible configurations are binary dummy variables taking the value of 1 for observations in which these configurations are observed and 0 otherwise, β_n (n = 1,2,3,4) are the estimates of the effect of these configurations on the dependent variable, conditional on a vector the control variables **Z**, and ε is an error term.[6] The dependent variable can be continuous, binary, or categorical.

Like QCA, this specification allows for the identification of necessary and sufficient conditions, equifinality, asymmetric causality, and for identifying causally core conditions. If β_3 is not significantly different from β_4, and if both of these coefficients are larger than β_1 and β_2 ($\beta_3 \approx \beta_4 > \beta_1, \beta_2$), then this is evidence that A is both a necessary and a sufficient condition for maximizing the probability of V occurring, conditional on the control variables **Z**.[7] Both A and B would appear to be necessary but insufficient conditions for V if $\beta_4 > \beta_1, \beta_2, \beta_3$. Finally, if $\beta_2 \approx \beta_3 \approx \beta_4 > \beta_1$, this suggests that both A and B are sufficient but unnecessary conditions for V.

The results suggest equifinality if the difference between the largest and second-largest betas is not statistically significant.[8] If $\beta_2 \approx \beta_3 > \beta_1, \beta_4$, this is evidence of asymmetric causality as the absence of a configuration associated with V (e.g., A•~B) will not necessarily lead to the absence of V. This is because (~A•B) is also associated with V. Furthermore, if $\beta_3 \approx \beta_4 > \beta_1, \beta_2$, then A can be inferred to be a causally core condition, whereas B does not appear to affect the outcome (the QCA equivalent of this result would be a complex solution A•B + A•~B → V, which simplifies to a parsimonious solution A → V).

The number of control variables to be included is the analysis limited solely by the degrees of freedom available in the data set, unlike QCA, where the number of causal conditions to be assessed faces greater constraints and "controlling" is usually not a goal of the analysis. If the estimated betas in the above regression are statistically significant and are not all equal to each other, a test for complementarity between conditions A and B can be performed.

To test for complementarity, substitute the estimated betas from the above regression into the lattice-theoretic definition of complementarity: A and B are complementary if $\beta_4 - \beta_2 > \beta_3 - \beta_1$. The statistic used to test whether this condition holds or not is a Wald distance test statistic, which corresponds to the minimum distance between the vector of estimated betas and a vector of hypothetical betas, which conforms to the definition of complementarity. In practice this statistic is calculated by using the estimated betas and their variance–covariance matrix to solve a minimization problem with inequality constraints.[9] Upper and lower bound critical values, which can be used to interpret this test statistic are given in Kodde and Palm (1986). In addition to testing the null hypothesis of complementarity, the null hypothesis of substitutability should also be tested. Doing so allows the researcher to see whether his data have the power to distinguish between the two hypotheses. This approach to testing for complementarity has been extended to test for pairwise complementarity in a set of more than two configurational elements (Mohnen and Röller 2005), and can easily be extended further to test for complementarity between combinations of numerous configurational elements.

A limitation of the lattice-theoretic approach described above is that configurational elements must be in binary form—either being used or not, with no allowance for degrees of implementation, unlike fuzzy sets. A further significant limitation is that the approach requires observations on all possible configurations for complementarity testing to be possible. If the researcher is interested in numerous causal conditions relating to social phenomena, it is highly unlikely that a given data set will have observations on all possible configurations of these conditions. This commonly occurring lack of observations on some configurations of causal conditions, known as limited diversity to practitioners of QCA, presents perhaps the main opportunity and the main challenge for integration of QCA with the lattice-theoretic approach.

The potential for integration arises from QCA being equipped to deal with limited diversity through the use of easy and difficult counterfactuals (Ragin 2008), thereby allowing for the differentiation between causally core, causally peripheral, and irrelevant conditions (Fiss 2011). When not all logically possible configurations are observed in the data, preventing the researcher from using a lattice-theoretic approach, QCA counterfactual analysis could be used to identify conditions that appear to be causally core. If not all conditions are found to be causally core, the number of possible configurations of causally core conditions be analyzed using the lattice-theoretic approach will be significantly lower than the number of configurations used in the QCA, and these configurations will be less likely to exhibit limited diversity. The lattice-theoretic approach could then be applied to test for complementarity between causally core conditions only, with noncore causal conditions being added to the set of control variables. QCA thus makes lattice-theoretic complementarity testing possible, and researchers using QCA may also benefit from following their analysis with a lattice-theoretic test of complementarity between core causal conditions to get insights about the relationship between the causal conditions and the outcome that could not be seen in the QCA results. In addition, the lattice-theoretic approach can also serve as a means of checking the robustness of QCA results to the inclusion of a large set of control variables and to the use of a continuous dependent variable.

A limitation of this combined approach is that there is of course no guarantee that the narrowing down of the set of causal conditions to include only those identified as being causally core by QCA will result in data that do not exhibit limited diversity. In such cases, the lattice-theoretic approach may still serve a purpose as a robustness check, but it would not be possible to carry out the complementarity-testing procedure. Finally, this approach to integrating QCA and regression depends upon the QCA counterfactual analysis procedure to narrow down the set of causal conditions. Future work developing the hybrid QCA-lattice-theory approach should therefore investigate the extent to which the omission of control variables, which are to be used in the lattice-theoretic analysis, from the set of causal conditions included in the QCA stage may produce QCA results that fail to identify core causal conditions that affect the outcome in a configurational manner with one or more of the omitted variables.

Conclusion

As QCA researchers broaden their scope of inquiry to not only include small-*N* situations but also large-*N* situations, the changes in associated terrain and competition from established econometric approaches necessitate new ways to conceptualize set-theoretic inquiry. The goal of our article has been to facilitate this development and to provide some direction regarding this extension of the QCA approach as well as drawing out promising opportunities to engage and integrate with econometric methods. To the QCA purist, this might appear to be problematic, given the deep-running philosophical differences between the set-theoretic and correlation-based approach; QCA is focused on the way that causal conditions combine, whereas regression analysis focuses on isolating net-effects. We do not wish to downplay these differences, and believe that our prior discussion has aimed to further clarify the relationship between QCA and correlation-based methods as both converge in their focus on large-*N* phenomena. Indeed, we believe that our argument for exploring the further integration of QCA and econometrics will only succeed if researchers are well aware and appreciative of these differences, as they are the basis for understanding the opportunities for complementarities between both approaches. Nevertheless, we feel that a push toward further potential integration and hybrid research strategies is in fact well founded on the pragmatic philosophy that underlies QCA and is reflected in its philosophy of engaging in a dialogue with the data. In our view, this integration presents an important and promising area of work that will require considerable methodological advancement. Much work remains, but we believe there is also much to be gained as we explore opportunities for added insight drawing on the strengths of each approach.

Notes

1. Although Vis (2012) refers to fifty to hundred cases as "moderately large *N*," we believe that settings with roughly hundred cases or more are commonly considered fully in (or almost fully in) the set of "large-*N*" studies.
2. A number of integrative approaches that we do not discuss have been proposed. One particular integrative approach that appears to hold some promise is the use of QCA to create a meaningful typology of entities at one level of analysis

before using dummy variables created according to this typology to account for contextual effects in a regression performed at lower level of analysis. Dotti Sani and Quaranta (2011) use such an approach to study the work-motherhood relation in Organisation for Economic Co-operation and Development (OECD) countries. Focusing on formally accounting for measurement error, Eliason and Stryker (2009), in another approach, do use goodness-of-fit tests to qualify the fit of fuzzy-set conditions and thereby to adapt fsQCA results to inferential logic based on falsification.

3. Maggetti and Levi-Faur (this issue) discuss strategies for dealing with potential measurement error in QCA, whereas Emmenegger, Kvist, and Skaaning (this issue) review comparative welfare-state research using QCA and find that not all studies carried out robustness checks of their findings.
4. Although the interested reader is encouraged to read these articles for a formal treatment of optimization on lattices and for the relevant mathematical proofs, we shall focus our discussion of this approach on the results necessary for its econometric operationalization.
5. The potential connection of lattice theory with (fs)QCA is also suggested by Zaytsev et al. (2012), who combine QCA with formal concept analysis (FCA) based on lattice theory to address problems of measurement in democracy studies.
6. The regression produces estimates for all four betas as it does not include a constant.
7. If V is continuous, then this result suggests that A is a necessary and sufficient condition for high V. If $\beta_3 \approx \beta_4 < \beta_1, \beta_2$ then this would suggest that A is a necessary and sufficient condition for low V.
8. If V is continuous, the above result would suggest equifinality with respect to a high V outcome. More generally for a continuous V, if the difference between two or more estimated betas is not statistically significant, these configurations are equifinal as they are mutually exclusive yet associated with the same value of the outcome variable.
9. See Mohnen and Röller (2005) for details of the test statistic and of the inequality-constrained minimization problem used to calculate it.

Dealing with Errors in QCA

Martino Maggetti[1,2] and David Levi-Faur[3,4]

DOI: 10.1177/1065912912468269f

Abstract

This paper discusses five strategies to deal with five types of errors in Qualitative Comparative Analysis (QCA): condition errors, systematic errors, random errors, calibration errors, and deviant case errors. These strategies are the comparative inspection of complex, intermediary, and parsimonious solutions; the use of an adjustment factor, the use of probabilistic criteria, the test of the robustness of calibration parameters, and the use of a frequency threshold for observed combinations of conditions. The strategies are systematically reviewed, assessed, and evaluated as regards their applicability, advantages, limitations, and complementarities.

Introduction: Errors and Criticisms of QCA

Strategies to deal with the possibility of error are essential tools in all types of social research. The challenge of error management can be broadly conceived as the challenge of forming a bridge between theory and empirical research in a world where some imprecision, uncertainty, and randomness is unavoidable. Any research study in the social sciences must contend with error, stemming from a variety of sources, including incomplete definitions of the constructs being measured, imperfect operationalization of the ideas contained in the corresponding concepts, and weaknesses of methods of assessment. This holds of course also for QCA, that, some argue, has limited capacity to deal with different types of errors that are commonplace in the social sciences. As QCA methods typically work under deterministic or quasi-deterministic assumptions, standard statistical techniques that are used to correct and minimize measurement error and other types of error do not apply. The researcher cannot straightforwardly

[1]University of Zurich, Switzerland
[2]University of Lausanne, Switzerland
[3]Hebrew University of Jerusalem, Israel
[4]Freie Universität Berlin, Germany

methods. The topic of set-theoretic MMR involves more issues than we have discussed here. There are important differences between process tracing after a QCA of necessity, vs. a QCA of sufficiency. For example, sufficient solutions usually involve conjunctions and, in contrast to necessity, cases that reduce coverage are targets for process tracing (Schneider & Rohlfing forthcoming). Further exploration of these differences is a worthwhile endeavor to strengthen causal inferences in research on necessity and sufficiency alike.

Notes

1. See Eliason and Stryker (2009) for a different procedure for the analysis of necessary conditions. Dion (1998) uses a Bayesian approach for the analysis of necessary conditions.
2. Rihoux and Lobe's (2009) terms "upstream" and "downstream"—introduced in their discussion of the Qualitative Comparative Analysis (QCA) research process and the role of case knowledge therein—only partially overlap with ours.
3. We say "main purpose" because, even in post-QCA process tracing, one might find hitherto overlooked evidence for changes in the population, concepts, measurement, and calibration.
4. We use this example for illustrative purposes only.
5. As mentioned, *MA* alone is not necessary. We nevertheless start with a single condition to illustrate process tracing in the most basic setting of just one condition to identify potentially omitted terms.
6. Using simulated data, an online appendix to our paper demonstrates that our formulas produce plausible results (http://prq.sagepub.com/supplemental/).
7. If the formula nevertheless yields the same score for multiple cases, one should choose the one with higher membership in *Y*.
8. This holds true because the logical OR operator requires assigning cases the *maximum* set membership across all conditions combined by logical OR (Ragin 2000, 175).
9. Alternatively, they contribute to the trivialness of the necessary condition (Goertz 2006; Ragin 2006; Schneider and Wagemann 2012).
10. Pre-QCA studies of cases in Zone 3 might help to identify measurement and/or calibration error in either *X* (membership too easy) or *Y* (membership too difficult) and increase the relevance of *X*. These are not model-related modifications as we define them, though.
11. Goertz (2008, 11) calls this "choosing cases diversely."
12. Typical cases that are joint members should only be chosen if no unique members are available.
13. This selection strategy is the set-theoretic equivalent to the diverse case strategy (Seawright and Gerring 2008; Rohlfing 2012, chap. 3).
14. If two or more pairs of cases obtain the same score, researchers should choose the one with the largest difference in *Y*.
15. We know that the entire truth table row to which the typical case belongs is sufficient for the outcome. Every condition constituting this row is an INUS condition, and taking away any of these conditions might lead to the absence of the outcome (assuming that we analyze unique members and that the condition is not logically redundant). Consequently, case selection for comparative process tracing in the typical case and the IIR case must ensure that all INUS conditions are present in these cases.
16. Note that for process tracing on the mechanism behind the pattern of necessity, it only matters that cases are members of similar truth table rows, not how strong their membership in these rows are.
17. If two or more pairs of cases obtain the same score, researchers should choose the one with the largest difference in *Y*.
18. See the truth table in the online appendix (http://prq.sagepub.com/supplemental/).
19. If two or more pairs of cases obtain the same score, researchers should choose the one with the largest sum of membership scores in *Y*.
20. In the ideal scenario, the deviant cases consistency turn into typical cases if we were to add the omitted term to the solution.
21. If two or more pairs of cases obtain the same score, researchers should choose the one with the largest difference in *Y*.

Acknowledgements

The editors wish to thank Priscilla Álamos-Concha for her help in the fine-tuning of the manuscript.

Declaration of Conflict Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Charles Ragin acknowledges support from the National Science Foundation: NSF SciSIP and STS Programs, award #1057559.

References

Abell, Peter. 1990. "Supporting Industrial Cooperatives in Developing Countries: Some Tanzanian Experiences." *Economic and Industrial Democracy* 11 (4): 483–504.

Achen, Christopher. 2005. "Two Cheers for Charles Ragin." *Studies in Comparative International Development* 40 (1): 27–32.

Aleman, José. 2009. "The Politics of Tripartite Cooperation in New Democracies: A Multi-level Analysis." *International Political Science Review* 30 (2): 141–62.

Alon, Sigal. 2007. "Overlapping Disadvantages and the Racial/Ethnic Graduation Gap among Students Attending Selective Institutions." *Social Science Research* 36 (4): 1475–99.

Amenta, Edwin, Neal Caren, and Sheera J. Olaski. 2005. "Age for Leisure? Political Mediation and the Impact of the Pension Movement on US Old-Age Policy." *American Sociological Review* 70 (3): 516–38.

Amenta, Edwin, Bruce G. Carruthers, and Yvonne Zylan. 1992. "A Hero for the Aged? The Townsend Movement, the Political Mediation Model, and U.S. Old-Age Policy, 1934–1950." *American Journal of Sociology* 98 (2): 308–39.

Amenta, Edwin, and Drew Halfmann. 2000. "Wage Wars: Institutional Politics, WPA Wages, and the Struggle for U.S. Social Policy." *American Sociological Review* 65 (4): 506–28.

Amenta, Edwin, and Alexander Hicks. 2010. "Research Methods." In *The Oxford Handbook of the Welfare State*, edited by Francis Castles, Stephan Leibfried, Jane Lewis, Herbert Obinger, and Christopher Pierson, 105–20. Oxford: Oxford University Press.

Amenta, Edwin, and Jane D. Poulsen. 1994. "Where to Begin." *Sociological Methods & Research* 23 (1): 22–53.

Amenta, Edwin, and Jane D. Poulsen. 1996. "Social Politics in Context: The Institutional Politics Theory and Social Spending at the End of the New Deal." *Social Forces* 75 (1): 33–60.

Avdagic, Sabina. 2010. "When Are Concerted Reforms Feasible? Explaining the Emergence of Social Pacts in Western Europe." *Comparative Political Studies* 43 (5): 628–57.

Bennett, Andrew, Aharon Barth, and Kenneth R. Rutherford. 2003. "Do We Preach What We Practice? A Survey of Methods in Political Science Journals and Curricula." *Political Science and Politics* 36 (3): 373–8.

Berg-Schlosser, D., and Gisèle De Meur. 2009. Comparative Research Design: Case and Variable Selection. In *Configurational Comparative Methods. Qualitative Comparative Analysis (QCA) and Related Techniques*, edited by Benoît Rihoux and Charles Ragin, 19–32. Thousand Oaks: SAGE.

Berg-Schlosser, D., Gisèle De Meur, Benoît Rihoux, and Charles Ragin. 2009. "Qualitative Comparative Analysis (QCA) as an Approach." In *Configurational Comparative Methods. Qualitative Comparative Analysis (QCA) and Related Techniques*, edited by Benoît Rihoux and Charles Ragin, 1–18. Thousand Oaks: SAGE.

Blake, Charles H., and Jessica R. Adolino. 2001. "The Enactment of National Health Insurance: A Boolean Analysis of Twenty Advanced Industrial Democracies." *Journal of Heath Politics, Policy, and Law* 26 (4): 679–708.

Blatter, Joachim, Matthias Kreutzer, Michaela Rentl, and Jan Thiele. 2009. "Preconditions for Foreign Activities of European Regions: Tracing Causal Configurations of Economic, Cultural, and Political Strategies." *Publius: The Journal of Federalism* 40:171–99.

Bleijenbergh, Inge, and Conny Roggeband. 2007. "Equality Machineries Matter: The Impact of Women's Political Pressure on European Social-Care Policies." *Social Politics: International Studies in Gender, State and Society* 14 (4): 437–59.

Bochsler, Daniel. 2011. "It Is Not How Many Votes You Get, But Also Where You Get Them: Territorial Determinants and Institutional Hurdles for the Success of Ethnic Minority Parties in Post-Communist Countries." *Acta Politica* 46:217–38.

Braumoeller, Bear F. 2003. "Causal Complexity and the Study of Politics." *Political Analysis* 11:209–33.

Braumoeller, Bear F., and Gary Goertz. 2000. "The Methodology of Necessary Conditions." *American Journal of Political Science* 44 (4): 844–58.

Braumoeller, Bear F., and Yevgeniy Kirpichevsky. 2005. "When More Is Less: Integrating Qualitative Information and Boolean Statistics." *Political Analysis* 13:261–79.

Cassiman, Bruno, and R. Veugelers. 2006. "In Search of Complementarity in Innovation Strategy: Internal R&D and External Knowledge Acquisition." *Management Science* 52:68–82.

Chanson, Guillaume, Benoît Demil, Xavier Lecocq, and Pierre-Antoine Sprimont. 2005. "La place de l'analyse qualitative comparée en sciences de gestion" [The place of qualitative comparative analysis in management sciences]. *Finance Contrôle Stratégie* 3 (8): 29–50.

Chiappero-Martinetti, Enrica. 2000. "A Multidimensional Assessment of Well-Being Based on Sen's Functioning Approach." *Rivista Internazionale di Scienze Sociali* 2:207–39.

Clark, William R., Michael Gilligan, and Matt Golder. 2006. "A Simple Multivariate Test for Asymmetric Hypotheses." *Political Analysis* 14 (3): 311–31.

Collier, David, and Robert Adcock. 1999. "Democracy and Dichotomies: A Pragmatic Approach to Choices about Concepts." *Annual Review of Political Science* 1:537–65.

COMPASSS. 2011. "International Bibliographical Database." http://www.compasss.org/pages/resources/international.html.

Cronqvist, Lasse. 2011. *Tosmana: Tool for Small-N Analysis*. Trier, Germany: Department of Political Science, University of Trier.

Cronqvist, Lasse, and Dirk Berg-Schlosser. 2009. "Multi-value QCA (MVQCA)." In *Configurational Comparative Methods. Qualitative Comparative Analysis (QCA) and Related Techniques, Applied Social Research Methods*, edited by B. Rihoux and C. C. Ragin, 69–86, 167–77. Thousand Oaks: SAGE.

Cronqvist, Lasse. 2011. *Tosmana: Tool for Small-N Analysis*. Trier, Germany: Department of Political Science, University of Trier.

De Meur, Gisèle, and Benoît Rihoux, eds. 2002. *L'analyse quali-quantitative comparée (AQQC-QCA): Approche, techniques et applications en sciences humaines*. Louvain-la-Neuve, Belgium: Academia-Bruylant.

De Meur, Gisèle, Benoît Rihoux, and Sakura Yamasaki. 2009. "Addressing the Critiques of csQCA." In *Configurational Comparative Methods. Qualitative Comparative Analysis (QCA) and Related Techniques*, edited by Benoît Rihoux and Charles Ragin, 139–60. Thousand Oaks: SAGE.

Dion, Douglas. 1998. "Evidence and Inference in the Comparative Case Study." *Comparative Politics* 30:127–45.

Dotti Sani, Giulia M., and Mario Quaranta. 2011. "A Mixed Approach to Work-Motherhood Relation in OECD Countries." Paper prepared for presentation at the 6th General European Consortium of Political Science Conference, Panel "Mixed Methods." August 25–27, 2011, University of Iceland, Reykjavik.

Doty, D. Horald, W. H. Glick, and G. P. Huber. 1993. "Fit, Equifinality, and Organizational Effectiveness: A Test of Two Configurational Theories." *Academy of Management Journal* 36:1196–250.

Drass, Kriss A., and J. William Spencer. 1987. "Accounting for Pre-Sentencing Recommendations: Typologies and Probation Officers' Theory of Office." *Social Problems* 34 (3): 277–93.

Dul, Jan, Tony Hak, Gary Goertz, and Chris Voss. 2010. "Necessary Condition Hypotheses in Operations Management." *International Journal of Operations & Production Management* 30 (11): 1170–90.

Dusa, Adrian, and Alrik Thiem. 2012. "QCA: Qualitative Comparative Analysis. R Package Version 1.0-3."

Ebbinghaus, Bernhard. 2005. "When Less is More." *International Sociology* 20:133–52.

Eliason, Scott, and R. Stryker. 2009. "Goodness-of-Fit Tests and Descriptive Measures in Fuzzy-Set Analysis." *Sociological Methods & Research* 38:102–46.

Emmenegger, Patrick. 2008. "Religion und Arbeitnehmerschutzgesetzgebung: Eine Fuzzy-Set Analyse" [Religion and employment protection legislation: A fuzzy-set analysis]. *Swiss Political Science Review* 14 (1): 85–130.

Emmenegger, Patrick. 2011. "Job Security Regulations in Western Democracies: A Fuzzy Set Analysis." *European Journal of Political Research* 50 (3): 336–64.

Emmenegger, Patrick. 2012. "How Good Are Your Counterfactuals? Assessing Quantitative Macro-Comparative Welfare State Research with Qualitative Criteria." *Journal of European Social Policy* 21:365–80.

Fiss, Peer C. 2007. "A Set-Theoretic Approach to Organizational Configurations." *Academy of Management Review* 32:1180–98.

Fiss, Peer C. 2009. "Case Studies and the Configurational Analysis of Organizational Phenomena." In *Handbook of Case Study Methods*, edited by Charles Ragin and David Byrne, 424–40. London: SAGE.

Fiss, Peer C. 2011. "Building Better Causal Theories: A Fuzzy Set Approach to Typologies in Organizational Research." *Academy of Management Journal* 54 (2): 393–420.

Franchino, Fabio. 2005. "The Study of EU Public Policy: Results of a Survey." *European Union Politics, Forum Section* 6 (2): 243–52.

George, Alexander L., and Andrew Bennett. 2005. *Case Studies and Theory Development in the Social Sciences*. London: MIT Press.

Gjølberg, Maria. 2009. "The Origin of Corporate Social Responsibility: Global Forces or National Legacies." *Socio-Economic Review* 7 (4): 605–37.

Glaesser, Judith. 2008. "Just How Flexible is the German Selective Secondary School System? A Configurational Analysis." *International Journal of Research & Method in Education* 31 (2): 193–209.

Goertz, Gary. 2006. "Assessing the Trivialness, Relevance, and Relative Importance of Necessary or Sufficient Conditions in Social Science." *Studies in Comparative International Development (SCID)* 41 (2): 88–109.

Goertz, Gary. 2008. "Choosing Cases for Case Studies: A Qualitative Logic." *Newsletter of the APSA Section on Qualitative & Multi-Method Research* 6 (2): 11–4.

Goertz, Gary, and James Mahoney. 2005. "Negative Case Selection: The Possibility Principle." In *Social Science Concepts: A User's Guide*, edited by Gary Goertz, 177–210. Princeton: Princeton University Press.

Goertz, Gary, and Harvey Starr. 2003. "Introduction: Necessary Condition Logics, Research Design, and Theory." In *Necessary Conditions: Theory, Methodology, and Applications*, edited by Gary Goertz and Harvey Starr, 1–24. New-York: Rowman and Littlefield.

Goldthorpe, John H. 1997. "Current Issues in Comparative Macrosociology: A Debate on Methodological Issues." *Comparative Social Research* 16:1–26.

Gordon, Sanford C., and Alastair Smith. 2004. "Quantitative Leverage through Qualitative Knowledge: Augmenting the Statistical Analysis of Complex Causes." *Political Analysis* 12:233–55.

Gordon, Sanford C., and Alastair Smith. 2005. "Qualitative Leverage and the Epistemology of Expert Opinion." *Political Analysis* 13:280–91.

Greckhamer, Thomas. 2011. "Cross-Cultural Differences in Compensation Level and Inequality across Occupation: A Set-Theoretic Analysis." *Organization Studies* 32 (1): 85–115.

Greckhamer, Thomas, Vilmos Misangyi, Heather Elms, and Rodney Lacey. 2008. "Using Qualitative Comparative Analysis in Strategic Management Research: An Examination of Combinations of Industry, Corporate, and Business-Unit Effects." *Organizational Research Methods* 11: 695–726.

Greckhamer, Thomas, Vilmos Misangyi, and Peer Fiss. Forthcoming. "The Two QCAs: Small- and Large-N Comparative Approaches in Organization Studies." In *Research in Sociology of Organizations*, edited by Peer Fiss, Bart Cambré, and Axel Marx. Emerald Publishers

Grofman, Bernard, and Carsten Q. Schneider. 2009. "An Introduction to Crisp Set QCA, with a Comparison to Binary Logistic Regression." *Political Research Quarterly* 62:662–72.

Herrmann, Andrea M., and L. Cronqvist. 2009. "When Dichotomisation becomes a Problem for the Analysis of Middle-Sized Datasets." *International Journal of Social Research Methodology* 12 (1): 33–50.

Hicks, Alexander M. 1994. "Qualitative Comparative Analysis and Analytical Induction: The Case of the Emergence of the

Social Security State." *Sociological Methods & Research* 23:86–113.

Hicks, Alexander, Joya Mishra, and Tang Nah Ng. 1995. "The Programmatic Emergence of the Social Security State." *American Sociological Review* 60 (3): 329–49.

Hudson, John, and Stefan Kühner. 2010. "Beyond the Dependent Variable Problem: The Methodological Challenges of Capturing Productive and Protective Dimensions of Social Policy." *Social Policy and Society* 9 (2): 167–79.

Hug, Simon. 2012. "Limitations of QCA." *APSA—Comparative Politics Newsletter* 22 (1): 6.

Jang, Dong-Ho. 2009. "Significance of Variations between Income Transfers and Social Care Services Development." *Journal of Comparative Social Welfare* 25 (1): 37–48.

Janoski, Thomas, and Alexander Hicks. 1994. *The Comparative Political Economy of the Welfare State*. Cambridge: Cambridge University Press.

Jordan, Elizabeth, Martha Gross, Amy Nicole Javernick-Will, and Michael Arvin. 2011. "Use and Misuse of Qualitative Comparative Analysis." *Construction Management and Economics* 29 (11): 1159–73.

Kenworthy, Lane, and Alexander Hicks. 2008. *Method and Substance in Macrocomparative Analysis*. New Hampshire: Palgrave Macmillan.

Kim, Kyo-seong, and Yeon Jung Lee. 2008. "A Qualitative Comparative Analysis of Strategies for an Ageing Society, with Special Reference to Pension and Employment Policies." *International Journal of Social Welfare* 17:225–35.

Kittel, Bernhard, Herbert Obinger, and Uwe Wagschal. 2000. "Die gezügelten Wohlfahrtsstaaten im international Vergleich" [The tamed welfare state in international comparative perspective]. In *Der gezügelte Wohlfahrtsstaat*, edited by Herbert Obinger and Uwe Wagschal, 329–64. Frankfurt, Germany: CAMPUS.

Kodde, David A., and F. C. Palm. 1986. "Wald Criteria for Jointly Testing Equality and Inequality Restrictions." *Econometrica* 54:1243–8.

Koenig-Archibugi, Mathias. 2004. "Explaining Government Preferences for Institutional Change in EU Foreign and Security Policy." *International Organization* 58 (1): 137–74.

Kogut, Bruce, and Charles Ragin. 2006. "Exploring Complexity When Diversity is Limited: Institutional Complementarity in Theories of Rule of Law and National Systems Revisited." *European Management Review* 3 (1): 44–59.

Kvist, Jon. 1999. "Welfare Reform in the Nordic Countries in the 1990s: Using Fuzzy-Set Theory to Assess Conformity to Ideal Types." *Journal of European Social Policy* 9 (3): 231–52.

Kvist, Jon. 2007. "Fuzzy Set Ideal Type Analysis." *Journal of Business Research* 60 (5): 474–81.

Lacey, Rodney, and P. C. Fiss. 2009. "Comparative Organizational Analysis across Multiple Levels: A Set-Theoretic Approach." In *Research in the Sociology of Organizations: Comparative Approaches to Organizational Research*, edited by Brayden King, Teppo Felin, and David Whetten, 91–116. Bingley, UK: Emerald Publishers.

Lebow, Richard Ned. 2010. *Forbidden Fruit: Counterfactuals and International Relations*. Princeton: Princeton University Press.

Lee, Sophia Seung-yoon. 2011. Fuzzy-Set Method in Comparative Social Policy: A Critical Introduction and Review of the Applications of the Fuzzy-Set Method. *Quality & Quantity* 45:1–18.

Lieberman, Evan S. 2005. "Nested Analysis as a Mixed-Method Strategy for Comparative Research." American Political Science Review 99:435–52.

Lieberson, Stanley. 1991. "Small N's and Big Conclusions: An Examination of the Reasoning in Comparative Studies Based On a Small Number of Cases." *Social Forces* 70: 307–20.

Lieberson, Stanley. 1994. "More on the Uneasy Case for Using Mill-Type Methods in Small N Comparative Studies." *Social Forces* 72:1225–37.

Lieberson, Stanley. 2004. "Comments on the Use and Utility of QCA." *Qualitative Methods* 2 (2): 13–4.

Lipset, Seymour Martin. 1959. "Some Social Requisites of Democracy: Economic Development and Political Legitimacy." *American Political Science Review* 53:69–105.

Long, J. Scott. 1997. *Regression Models for Categorical and Limited Dependent Variables*. Thousand Oaks: SAGE.

Longest, Kyle C., and Stephen Vaisey. 2008. "Fuzzy: A Program for Performing Qualitative Comparative Analysis (QCA) in Stata." *The State Journal* 8 (1): 79–104.

Maggetti, Martino. 2007. "De Facto Independence after Delegation: A Fuzzy-Set Analysis." *Regulation & Governance* 1 (4): 271–94.

Maggetti, Martino. 2012. *Regulation in Practice*. Colchester, England: ECPR Press.

Mahoney, James, Erin Kimball, and Kendra L. Koivu. 2009. "The Logic of Historical Explanation in the Social Sciences." *Comparative Political Studies* 42 (1): 114–46.

Marx, Axel. 2010. "Crisp-Set Qualitative Comparative Analysis (csQCA) and Model Specification: Benchmarks for Future csQCA Applications." *International Journal of Multiple Research Approaches* 4 (2): 138–58.

Marx, Axel, Bart Cambré, and Benoît Rihoux. 2012. "Crisp-Set Qualitative Comparative Analysis and the Configurational Approach. Assessing the Potential for Organizational Studies." In *Research in Sociology of Organizations*, edited by P. Fiss, Bart Cambré, and Axel Marx. Bingley, UK: Emerald Publishers.

Marx, Axel, and Adrian Dusa. 2011. "Crisp-Set Qualitative Comparative Analysis (csQCA), Contradictions and Consistency Benchmarks for Model Specification." *Methodological Innovations Online* 6 (2): 103–148.

Marx, Axel, Benoît Rihoux, and Charles Ragin. Forthcoming. "The Origins, Development and Application of Qualitative Comparative Analysis (QCA): The First 25 Years. *European Political Science Review*.

Mendel, Jerry M., and Charles C. Ragin. 2011. "fsQCA: Dialog Between Jerry M. Mendel and Charles C. Ragin." *Electrical Engineering*. www.compasss.org.

Miethe, Terance D., and Kriss A. Drass. 1999. "Exploring the Social Context of Instrumental and Expressive Homicides: An Application of Qualitative Comparative Analysis." *Journal of Quantitative Criminology* 15 (1): 1–21.

Milgrom, Paul, and J. Roberts. 1990. "The Economics of Modern Manufacturing: Technology, Strategy and Organization." *American Economic Review* 80:511–28.

Milgrom, Paul, and J. Roberts. 1995. "Complementarities and Fit: Strategy, Structure, and Organizational Change in Manufacturing." *Journal of Accounting and Economics* 19:179–208.

Misra, Joya. 2003. "Women as Agents in Welfare State Development: A Cross-National Analysis of Family Allowance Adoption." *Socio-Economic Review* 1 (2): 185–214.

Mohnen, Pierre, and L-H. Röller. 2005. "Complementarities in Innovation Policy." *European Economic Review* 49:1431–50.

Most, Benjamin A., and Harvey Starr. 1989. *Inquiry, Logic, and International Politics*. Columbia: University of South Carolina Press.

Peillon, Michel. 1996. "A Qualitative Comparative Analysis of Welfare Legitimacy." *Journal of European Social Policy* 6 (3): 175–90.

Pennings, Paul. 2003. "Beyond Dichotomous Explanations. Explaining Constitutional Control of the Executive with Fuzzy-Sets." *European Journal of Political Research* 42 (4): 541–567

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

Ragin, Charles C. 1997. "Turning the Tables: How Case-Oriented Research Challenges Variable-Oriented Research." *Comparative Social Research* 16:27–42.

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

Ragin, Charles C. 2005. "Core versus Tangential Assumption in Comparative Research." *Studies in Comparative International Development* 40 (1): 33–8.

Ragin, Charles C. 2006a. "How to Lure Analytic Social Science out of the Doldrums: Some Lessons from Comparative Research." *International Sociology* 21:633–46.

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

Ragin, Charles C. 2008. *Redesigning Social Inquiry: Fuzzy Sets and Beyond*. Chicago: University of Chicago Press.

Ragin, Charles C. 2009a. *Fuzzy-Set/Qualitative Comparative Analysis*. University of Arizona.

Ragin, Charles C. 2009b. "Qualitative Comparative Analysis Using Fuzzy Sets (fsQCA)." In *Configurational Comparative Methods. Qualitative Comparative Analysis (QCA) and Related Techniques*, edited by Benoît Rihoux and Charles Ragin, 87–121. Thousand Oaks: SAGE.

Ragin, Charles C., and Peer Fiss. 2008. "Net Effects Analysis Versus Configurational Analysis: An Empirical Demonstration." In *Redesigning Social Inquiry: Fuzzy Sets and Beyond*, edited by Charles Ragin, 190–212. Chicago: University of Chicago Press.

Ragin, Charles, and Sean Davey. 2012. *fs/QCA, Version 2.5*. Tucson: University of Arizona.

Ragin, Charles C., Susan E. Mayer, and Kriss A. Drass. 1984. "Assessing Discrimination: A Boolean Approach." *American Sociological Review* 49 (2): 221–34.

Ragin, Charles C., and Benoît Rihoux. 2004a. "Qualitative Comparative Analysis (QCA): State of the Art and Prospects." *Qualitative Methods* 2 (2): 3–13. (lead article in an issue devoted to QCA).

Ragin, Charles C., and Benoît Rihoux. 2004b. "Replies to Commentators: Reassurances and Rebuttals." *Qualitative Methods* 2 (2): 22–4.

Ragin, Charles C., David Shulman, Adam Weinberg, and Brian Gran. 2003. "Complexity, Generality, and Qualitative Comparative Analysis." *Field Methods* 15:323–40.

Ragin, Charles C., and John Sonnett. 2004. "Between Complexity and Parsimony: Limited Diversity, Counterfactual Cases and Comparative Analysis." In *Vergleichen in der Politikwissenschaft*, edited by Michael Minkenberg and Sabine Kropp, 180–97. Wiesbaden: VS Verlag.

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

Raunio, Tapio. 2005. "Holding Governments Accountable in European Affairs: Explaining Cross-National Variation." *The Journal of Legislative Studies* 11 (3–4): 319–42.

Regoeczi, Wendy C., and Terance D. Miethe. 2003. "Taking on the Unknown a Qualitative Comparative Analysis of Unknown Relationship Homicides." *Homicide Studies* 7 (3): 211–34.

Reichert, Christopher, and Claude Rubinson. 2012. *KirqST, Version 1.8*. Houston: University of Houston-Downtown.

Rihoux, Benoît. 2003. "Bridging the Gap Between the Qualitative and Quantitative Worlds? A Retrospective and Prospective View on Qualitative Comparative Analysis." *In Field Methods* 15 (4): 351–65.

Rihoux, Benoît, and Gisèle De Meur. 2009. "Crisp-Set Qualitative Comparative Analysis (csQCA)." In *Configurational comparative methods. Qualitative Comparative Analysis (QCA) and Related Techniques*, edited by Benoît Rihoux and Charles Ragin, 33–68. Thousand Oaks: SAGE.

Rihoux, Benoît, and Charles C. Ragin, eds. 2009. *Configurational Comparative Methods. Qualitative Comparative Analysis (QCA) and Related Techniques*. Thousand Oaks: SAGE.

Rihoux, Benoît, and Bojana Lobe. 2009. "The Case for Qualitative Comparative Analysis (QCA): Adding Leverage for Thick Cross-Case Comparison." In *The Sage Handbook of Case—Based Methods*, edited by David Byrne and Charles Ragin, 222–43. London: SAGE.

Rihoux, Benoît, Charles C. Ragin, Sakura Yamasaki, and Damien Bol. 2009. "Conclusions—The Way(s) Ahead." In *Configurational Comparative Methods. Qualitative Comparative Analysis (QCA) and Related Techniques*, edited by Benoît Rihoux and Charles Ragin, 167–77. Thousand Oaks: SAGE.

Rihoux, Benoît, Ilona Rezsöhazy, and Damien Bol. 2011. "Qualitative Comparative Analysis (QCA) in Public Policy Analysis: An Extensive Review." *German Policy Studies* 7 (3): 9–82.

Rohlfing, Ingo. 2008. "What You See and What You Get: Pitfalls and Principles of Nested Analysis in Comparative Research." *Comparative Political Studies* 41:1492–1514.

Rohlfing, Ingo. 2012. *Case Studies and Causal Inference: An Integrative Framework*. Basingstoke, England: Palgrave Macmillan.

Sager, Fritz. 2004. "Institutions Métropolitaines et Coordination des Politiques Publiques: Une AQQC des Arrangements Politico-Administratifs d'Articulation entre Urbanisme et Transports en Europe" [Institutional conditions for collective competence in urban areas: A QCA analysis of 17 decision cases]. *Revue Internationale de Politique Comparée* 11 (1): 67–84.

Sartori, Giovanni. 1970. "Concept Misformation in Comparative Politics." *American Political Science Review* 64 (4): 1033–53.

Savolainen, Jukka. 1994. "The Rationality of Drawing Big Conclusions Based on Small Samples: In Defense of Mill's Methods." *Social Forces* 72:1217–24.

Schneider, Carsten Q. 2009. *The Consolidation of Democracy. Comparing Europe and Latin America*. London: Routledge.

Schneider, Carsten Q., and Ingo Rohlfing. Forthcoming. "Combining QCA and Process Tracing in Set-Theoretic Multi-Method Research." *Sociological Methods & Research.*

Schneider, Carsten Q., and Claudius Wagemann. 2007. *QCA und fsQCA. Ein einführendes Lehrbuch für Anwender und jene, die es werden wollen* [QCA and fsQCA. An introductory textbook for users and those who want to become so]. Opladen: Barbara-Budrich-Verlag.

Schneider, Carsten Q., and Claudius Wagemann. 2010. "Standards of Good Practice in Qualitative Comparative Analysis (QCA) and Fuzzy Sets." *Comparative Sociology* 9 (3): 397–418.

Schneider, Carsten Q., and Claudius Wagemann. 2012. *Set-Theoretic Methods in the Social Sciences. A Guide to Qualitative Comparative Analysis*. Cambridge: Cambridge University Press.

Schneider, Martin R., Conrad Schulze-Bentrop, and Mihai Paunescu. 2010. "Mapping the Institutional Capital of High-Tech Firms: A Fuzzy-Set Analysis of Capitalist Variety and Export Performance." *Journal of International Business Studies* 41:246–66.

Seawright, Jason. 2005. "Qualitative Comparative Analysis vis-à-vis Regression." *Studies in Comparative International Development* 40 (1): 3–26.

Seawright, Jason, and John Gerring. 2008. "Case Selection Techniques in Case Study Research: A Menu of Qualitative and Quantitative Options." *Political Research Quarterly* 61:294–308.

Skaaning, Svend-Erik. 2011. "Assessing the Robustness of Crisp-Set and Fuzzy-Set QCA Results." *Sociological Methods & Research* 40 (2): 391–408.

Tarrow, Sidney. 2010. "The Strategy of Paired Comparison: Toward a Theory of Practice." *Comparative Political Studies* 43:230–259.

Tetlock, Philip E., and Aaron Belkin, eds. 1996. *Counterfactual Thought Experiments in World Politics*. Princeton: Princeton University Press.

Thiem, Alrik, and Adrian Dusa. 2012. *Qualitative Comparative Analysis with R: A User's Guide*. New York: Springer.

Topkis, Donald M. 1978. "Minimizing a Submodular Function on a Lattice." *Operations Research* 26:305–21.

Vanderborght, Yannick, and Sakura Yamasaki. 2004. "Des cas logiques . . . contradictoires? Un piège de l'AQQC déjoué à travers l'étude de la faisabilité politique de l'Allocation Universelle" [Logical Cases . . . in contradiction? An exploration of QCA applied to the debate on a Universal Basic Income]. *Revue Internationale de Politique Comparée* 11 (1): 51–66.

Vink, Maarten, and Olaf Van Vliet. 2009. "Not Quite Crisp, Not Yet Fuzzy? Assessing the Potentials and Pitfalls of Multi-Value QCA." *Field Methods* 21 (9): 265–89.

Vis, Barbara. 2007. "States of Welfare or States of Workfare? Welfare State Restructuring in 16 Capitalist Democracies, 1985–2002." *Policy & Politics* 35 (1): 105–22.

Vis, Barbara. 2009a. "Governments and Unpopular Social Policy Reform: Biting the Bullet or Stearing Clear." *European Journal of Political Research* 48 (1): 31–57.

Vis, Barbara. 2009b. "The Importance of Socio-Economic and Political Losses and Gains in Welfare State Reform." *Journal of European Social Policy* 19 (5): 395–407.

Vis, Barbara. 2011. "Under Which Conditions Does Spending on Active Labor Market Policies Increase? A fsQCA Analysis of 53 Governments Between 1985 and 2003." *European Political Science Review* 3 (2): 229–52.

Vis, Barbara. 2012. "The Comparative Advantages of fsQCA and Regression Analysis for Moderately Large-N Analyses." *Sociological Methods & Research* 41 (1): 168–98.

Williams, Linda Meyer, and Ronald A. Farrell. 1990. "Legal Response to Child Sexual Abuse in Day Care." *Criminal Justice and Behavior* 17 (3): 284–302.

Yamasaki, Sakura, and Benoît Rihoux. 2009. "A Commented Review of Applications." In *Configurational Comparative Methods. Qualitative Comparative Analysis (QCA) and Related Techniques*, edited by Benoît Rihoux and Charles Ragin, 123–45. Thousand Oaks: SAGE.

Zaytsev, Dmitry, S. Obiedkov, M. Shabanova, and M. Klimushkin. 2012. "Formal Concept Analysis Framework As a Tool that Broaden Qualitative Comparative Analysis Technique: Analyzing Democratic Development. http://www.hse.ru/data/2012/05/04/1250456063/Zaytsev_FCA%20&;%20QCA_paper_full.doc.doc.