

Standards of Good Practice and the Methodology of Necessary Conditions in Qualitative Comparative Analysis: A Critical View on Schneider and Wagemann's Theory-Guided/Enhanced Standard Analysis

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Abstract: The analysis of necessary conditions for some outcome of interest has long been one of the main preoccupations of scholars in all disciplines of the social sciences. In this connection, the introduction of Qualitative Comparative Analysis (QCA) in the late 1980s has revolutionized the way research on necessary conditions has been carried out. Standards of good practice for QCA have long demanded that the results of preceding tests for necessity constrain QCA's core process of Boolean minimization so as to enhance the quality of the solution. Schneider and Wagemann's Theory-Guided/Enhanced Standard Analysis (T/ESA) is currently being adopted by applied researchers as the new state of the art in this respect. In drawing on Schneider and Wagemann's own illustrative data example and a meta-analysis of 36 truth tables across 21 published studies that have adhered to current standards of good practice in QCA, I demonstrate, however, that T/ESA and its methodological predecessors defeat their purpose once a hitherto unacknowledged bias in tests of necessity relations is corrected. In conclusion, I urge that methodologists of QCA stop misleading applied researchers by declaring their latest ideas to be standards of good practice before these have undergone sufficient evaluation by other researchers.

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Standards of Good Practice and the Methodology of Necessary Conditions in Qualitative Comparative Analysis: A Critical View on Schneider and Wagemann's Theory-Guided/Enhanced Standard Analysis

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Introduction

Tests for the necessity of conditions with respect to some outcome of interest have long been one of the main preoccupations of researchers across all disciplines of the social sciences, from economics over political science to sociology (Braumoeller and Goertz 2000; Goertz 2003; Goertz and Mahoney 2012, 12). For example, economic historians have been convinced that “one necessary condition for the creation of modern economies dependent on specialization and division of labor [...] is the ability to engage in secure contracting across time and space” (North and Weingast 1989, 831); political scientists have surmised that “[t]he coherence in authority relations of a polity is a *necessary* condition for the lengthy persistence of that polity” (Lichbach 1981, 54); and sociologists have argued that “the establishment of juvenile reformatories was a necessary precondition for changes in the legal status of children” during the development phase of state juvenile codes in the United States (Sutton 1983, 529). The analysis of necessary conditions has been so central to the work of social scientists that entire books are exclusively devoted to this subject (e.g., Goertz and Starr 2003).

The significance of research on necessary conditions has received a further, major boost with the introduction of Qualitative Comparative Analysis (QCA) in the late 1980s (Ragin 1987). While scientists had previously been restricted to bifactorial designs (e.g., Lichbach 1981), QCA suddenly made it possible to bring a formal method with a sophisticated mathematical machinery imported from electrical engineering (McCluskey 1965) and analytical philosophy (Quine 1952) to bear on high-dimensional social data. The words of Alexander Hicks (1994, 99) mirror the enthusiasm at that time: “[...] as a logical method, the Millian approach, although it can be applied to a series of bivariate relations, is too undeveloped for truly multivariate analyses [...]. The Boolean procedures of QCA break the Millian logjam [...]”. Even those who were to later position themselves among the staunchest critics of QCA admitted that, at the time, they had been “[f]ired up by Ragin’s use of the Boolean approach” (Liebersohn 2004, 14). Nowadays, QCA is a family of four related variants (Thiem 2014b), the number of applications is about twenty times as large as

during the 1990s (Rihoux et al. 2013), the method is used in many areas other than its home turf of macro-sociology (Thiem and Duşa 2013c, 506), and numerous top journals of the social sciences publish applied QCA articles.¹

The authors of applied articles have often followed instructive guidelines on the use of QCA enshrined by some first and second-generation methodologists in so-called *standards of good practice* (Ragin 2000; Rihoux and Ragin 2009; Schneider and Wagemann 2010), whose purpose it is to “help authors, readers, and reviewers to become aware of how a given study deviates from an ideal application” (Schneider and Wagemann 2012, 275). Generally, following such guidelines is entirely rational as it ensures a useful division of labor between those with interests in applied issues and those who occupy themselves with technical questions about formal methods for causal inference. Not surprisingly in this relation, the article “Standards of Good Practice in Qualitative Comparative Analysis (QCA) and Fuzzy-Sets” by Schneider and Wagemann (2010) has become one of the most cited works of the QCA literature, having been referenced 240 times so far according to Google Scholar.²

An important one of these standards of good practice demands that the results of tests for the necessity of conditions with respect to the outcome being analyzed constrain the subsequent process of Boolean minimization so as to enhance the quality of the solution. Based on earlier work by Ragin (2000; 2009), Schneider and Wagemann’s (2012, 197-219; 2013) Theory-Guided/Enhanced Standard Analysis (T/ESA) is currently being adopted by applied researchers as the new state-of-the-art procedure to this end (e.g., Thomann 2015). However, I show in this article that T/ESA and its methodological predecessors defeat their own purpose of seeking enhanced parsimonious and intermediate solutions once a hitherto unacknowledged bias in necessity tests is corrected.³

¹ See <http://www.compass.org/bibdata.htm> for a bibliography of QCA publications.

² See <https://scholar.google.com/citations?user=h8S1vnAAAAAJ&hl=en> (accessed 12 November 2015).

³ Another strong argument against T/ESA has recently been presented by Cooper and Glaesser (2015). My argument follows a different line of reasoning.

The structure of my argument is as follows. In the first section, I outline how the concept of necessity is currently understood in QCA, and explain why this conception is erroneous. In the second section, I introduce the first two stages of T/ESA, and demonstrate why the rationale behind this technique collapses when the necessity analysis conducted prior to Boolean minimization is maximally objective.⁴ The third and final section reveals this effect to be omnipresent in applied research by means of a meta-analysis of 36 truth tables across 21 published QCA studies that have adhered to current QCA standards of good practice on necessity tests formulated in Ragin (2000) and Schneider and Wagemann (2010; 2012).

Current QCA Practice in Analyzing Necessity Relations

Recall the three examples of research on necessary condition from economics, political science and sociology in the introduction of this article. Perhaps, it was already conspicuous that all involved a causally interpreted relation between the outcome and *one* simple condition. This commonality is no result of happenstance. *Necessary conditions in virtually all social-scientific research consist of atomic conditions to which causal relevance is ascribed.* Neither the possibility of compound conditions nor the dissociation of the concept of necessity from that of causality is part of current thinking on the concept of necessity.

With specific regards to the literature on QCA and related methods, Schneider and Wagemann (2012), for instance, are even willing to commit a logical contradiction because they cannot imagine a simple disjunction to be a necessary condition without this condition being unifiable by some *single*, higher-order concept. These authors write in relation to an empirical example in their textbook's section on necessary conditions that, although "condition $\sim A+C$ [...] passes the criterion for being a necessary condition for Y", because Y is demonstrably sufficient for

⁴ I do not imply by doing so that such necessity analyses are purposeful. In fact, I would argue the opposite since necessary conditions need not be difference-makers, but this more fundamental argument against preceding tests for necessary conditions need not be made for proving T/ESA ill-conceived.

$\sim A+C$, they “advise against interpreting $\sim A+C$ as a necessary condition” (p.74).⁵ Wagemann and Schneider (2015, 41) then try to solve this propositional dissonance by explicitly arguing that analyses of necessity should be “performed on the basis of *isolated* [that is, atomic] conditions and their complements” (emphasis and comment in square brackets added).

That the property of causal relevance is directly ascribed to necessary conditions is most clearly demonstrated by Mahoney, Kimball and Koivu (2009, 118), who argue that “[w]ith a set-theoretic approach, a necessary cause can be defined as: X_1 is a necessary cause of Y_1 if Y_1 is a subset of X_1 .” However, the formal definition of the Boolean operation of implication underlying every relation of necessity, $P \leftarrow Q \equiv P + \sim Q \equiv \sim[\sim P Q]$ (cf. Thiem, Baumgartner, and Bol 2015) neither entails anything about the structure of P , nor that some higher-order concept must connect disjuncts p_1, p_2, \dots, p_j in P conceptually, nor that P ’s status as a superset of Q , which is equivalent to P being necessary for Q , renders P a cause of Q .

For example, in every QCA solution that exhibits perfect consistency and coverage, the disjunction of minimally sufficient conditions for the outcome is also minimally *necessary* for that outcome, but no concept linking these disjuncts other than “potential cause of the analyzed effect” is required. It is also true that, irrespective of coverage, all outcomes are necessary for their causes, which may sound counterintuitive to QCA researchers because of their misconception of necessary conditions as being isolated causes of given effects. Yet, being poisoned is necessary for being bitten by a rattlesnake, wet streets are necessary for rain, and car accidents are necessary for falling asleep behind the steering-wheel right before bends. Moreover, the Boolean Law of Monotonicity says with respect to necessary conditions that if some phenomenon P is necessary for some other phenomenon Q , where P is anything (P could, for instance, be an atomic condition, an effect, a disjunction of atomic conditions that is minimally necessary for Q , or even a minimally necessary disjunction of minimally sufficient conditions of Q), then $P \vee \Psi$, where Ψ is anything other than P ,

⁵ To remain consistent, I continue using “+” to denote the logical OR and “ \sim ” to denote the logical NOT. As is customary, the logical AND-operator will be dropped if there is no ambiguity.

will also always be necessary for Q (cf. Baumgartner 2008). Put differently, *necessity* is no relational property of an object that is conferred onto it by the causal interpretation of a researcher, but only by the algebraic laws that define the operation of necessity in conjunction with the data in hand. With these mere logical facts now put into place, the next section shows why the correction of a hitherto unacknowledged bias against compound conditions in tests for necessity relations prior to Boolean minimization makes T/ESA and its methodological predecessors fall apart.

The COSO-Effect

The problematic part of T/ESA to be addressed in this article consists of the procedure's first two stages. In the first stage, necessary conditions of the outcome are identified; in the second, the results of the preceding stage are used in barring what Schneider and Wagemann (2013) call *incoherent counterfactuals of type 1*—remainders that are incompatible with the results of the first stage—from being used by the Quine-McCluskey algorithm (QMC) as simplifying assumptions.⁶ According to its inventors, T/ESA therefore ensures that “necessary conditions do not disappear from solution terms of sufficiency due to assumptions made on logical remainders” (Schneider and Wagemann 2012, 209).

For illustrating T/ESA, Schneider and Wagemann (2013, 213) construct the truth table shown in Table 1, based on fuzzy-set data initially presented in Ragin (2009, 95) on the survival of democracy in interwar European countries.

TABLE 1 ABOUT HERE

The endogenous factor measures whether democracy survived during the interwar period in the country (S). The exogenous factors include a measure of whether the country was economically

⁶ QMC is widely taken to be the very heart of QCA (Baumgartner 2009, 74; Fiss 2007, 1184; Ragin 2008, 135; Rihoux and De Meur 2009, 33; Schneider and Wagemann 2012, 104-115).

developed (D), whether it was urbanized (U), whether it had a high literacy rate (L), whether it was industrialized (I), and whether it was politically stable (G). For these data, Schneider and Wagemann (2013, 212) identify and present L and G as the only two necessary conditions of S . The parsimonious solution, which the authors then report, comprises exactly one model, namely \mathbf{m}_1 in Expression (1).

$$\mathbf{m}_1: \quad D \sim I + UG \rightarrow S \quad (1)$$

As usual, a question mark in the column “Output” in Table 1 signifies a remainder; a tick mark in the column “SA” means that this remainder has been used as a simplifying assumption in the derivation of \mathbf{m}_1 ; and a tick mark in the column “IC₁” indicates that this remainder has been identified by Schneider and Wagemann (2013, 212-213) as an incoherent counterfactual of type 1. T/ESA would thus induce QMC to generate model \mathbf{m}_2 in Expression (2) after its first two stages since any remainder featuring either $\sim L$ or $\sim G$ is made unavailable to the algorithm’s minimization machinery.

$$\mathbf{m}_2: \quad DL \sim IG + ULG \rightarrow S \quad (2)$$

Let us see what happens once the arbitrary restriction on the complexity of necessary conditions is lifted and the bias against any conditions other than atomic ones corrected. Table 2 lists all eight minimally necessary conditions that result from an exhaustive and unbiased search.⁷ As Schneider and Wagemann (2012, 143) propose an inclusion cut-off of 0.9, this value is also applied here; coverage scores are provided for completeness but are no criterion for the necessity of

⁷ All analyses have been carried out with the *QCA* software package for *R*, whose *superSubset* function can be used for this purpose (Duşa and Thiem 2014; Thiem and Duşa 2013a; Thiem and Duşa 2013b). Note that for every complex conjunction that proves necessary for the outcome, *superSubset* will also list the statistics for the individual conditions of this conjunction, which are not treated as separate conditions in this article as doing so would be redundant.

a condition. The column “Negation” in Table 2 presents the respective logical negation of the identified condition, and the ID of this negated condition is listed in the last column of Table 2 and the column “ID” in Table 1.

TABLE 2 ABOUT HERE

It is notable that each remainder row in Table 1 has at least one ID entry, which means that no remainder is eligible for being included by QMC into the process of minimization because this would be irreconcilable with at least one statement of necessity according to T/ESA. Thus, T/ESA would force QMC to output model \mathbf{m}_3 in Expression (3) in its second stage.

$$\mathbf{m}_3: \quad D \sim UL \sim IG + DULIG \rightarrow S \quad (3)$$

Yet, by inspecting rows 1 and 2 of Table 1, it is easy to see that \mathbf{m}_3 corresponds to the conservative solution, without any minimization whatsoever having taken place. Instead of enhancing parsimonious and intermediate solutions, an implementation of T/ESA on the basis of an unbiased necessity analysis seems to leave but one choice for QMC, namely to generate the conservative solution. Put differently, T/ESA appears to defeat its own purpose, a phenomenon I refer to as the *COSO-Effect* because, following an objective necessity analysis, T/ESA will force QMC to output conservative solutions instead of enhanced parsimonious and intermediate ones.

The Prevalence of the COSO-Effect: A Meta-Analysis

The above example represented a single data experiment. This section now investigates how widespread the COSO-Effect is in applied research. To this end, I have collected 21 data sets from published QCA articles which have conducted a necessity analysis prior to Boolean minimization as

advised in corresponding standards of good practice.⁸ The complete list of studies with all results of this meta-analysis is available as a supplementary file to this article.

Nine studies present some necessary conditions, whereas eleven report to have not found any. With the exception of one study, which identified four conditions, the maximum number reported was two conditions. As almost all studies used an inclusion cut-off for the analysis of necessity that was different from that used for the analysis of sufficiency during the stage of minimization, I harmonized the cut-offs to the common value of 0.75, which Ragin (2008, 46) as well as Schneider and Wagemann (2012, 129) suggest for the analysis of sufficiency relations, because every statement of necessity can be turned into a logically equivalent statement of sufficiency and *vice versa*.⁹ For 23 outcomes, this modification increased the number of necessary conditions; for ten outcomes, it had a decreasing effect; and for three outcomes, it was inconsequential. I then re-ran QCA for each outcome, recorded the simplifying assumptions of each model of the corresponding solution, and tested whether the COSO-Effect bit.

The results allows of only one conclusion: the COSO-Effect is omnipresent. Apart from one solution for one of whose models no simplifying assumptions existed in the first place, one saturated truth table, and two outcomes for which no re-analysis was possible due to extreme model ambiguities (cf. Baumgartner and Thiem 2015; Thiem 2014a), the meta-analysis reveals that for about 91% of outcomes (29 out of 32), T/ESA forced QMC to bar all remainders that would have served as simplifying assumptions from being included in the minimization. That alone, however, does not mean the COSO-Effect is absent in the case of the remaining three outcomes. In point of

⁸ Data collected from <http://www.compass.org/bibdata.htm> (accessed 28 October 2015). The function called “ICtype1”, accessible as part of the replication file in the appendix to this article, returns the share of simplifying assumptions that would have been used by QMC by T/ESA from entering minimization, but ICtype1 itself uses the *e*QMC algorithm, which is in fact related to QMC in nothing but name (Duşa and Thiem 2015, Thiem 2015).

⁹ It remains unclear why the inclusion cut-off for an analysis of necessity should be different from that used for an analysis of sufficiency as suggested by Schneider and Wagemann (2012, 129, 143).

fact, for two outcomes, eight models out of eleven are beset; for one outcome, eight of ten models are affected; and for all eight models that are not affected, more than 92 percent of all remainders that would have been converted to simplifying assumptions were eliminated.

Conclusions

The analysis of necessary conditions has long been one of the main preoccupations of researchers across all disciplines of the social sciences. The introduction of Qualitative Comparative Analysis (QCA) in the late 1980s has provided a major boost to this existing interest. When applied researchers have employed QCA, they have often relied on instructive guidelines assembled and enshrined by some first and second-generation methodologists in standards of good practice.

According to these methodologists, an important standard of good practice is the identification of necessary conditions prior to Boolean minimization in order to constrain the use of simplifying assumptions by the Quine-McCluskey algorithm (QMC). Schneider and Wagemann's Theory-Guided/Enhanced Standard Analysis (T/ESA) is currently being adopted as the new state of the art in this respect. However, I have shown in this article that, when a hitherto unacknowledged bias against compound conditions in tests of necessity relations is corrected, T/ESA and its methodological predecessors defeat their purpose by forcing QMC to virtually always produce conservative solutions instead of enhanced parsimonious or intermediate ones. I have called this phenomenon the COSO-Effect. A meta-analysis of 36 truth tables from 21 published QCA articles that have adhered to current standards of good practice for the analysis of necessary conditions prior to Boolean minimization has revealed this effect to pervade applied research. These results call for a thorough re-evaluation of current standards of good practice for QCA.

While this methodological note has addressed a specific problem in current QCA-based research, it has simultaneously raised a more fundamental issue. If applied researchers are to continue trusting methodological guidelines, they need to be sure that the procedures claiming to help ensure that an analysis is being carried out properly have been extensively trialed and found

performing faultlessly. In light of the findings of this article, I therefore urge that methodologists of QCA stop issuing premature standards of good practice that have not yet undergone sufficient evaluation by other researchers. Standards of good practice for QCA, or any other method of empirical social research, should only be established through the informed consent of a larger community of appropriately trained scholars, and not by self-proclamation.

References

- Baumgartner, Michael. 2008. Regularity theories reassessed. *Philosophia* 36(3):327-54.
- . 2009. Inferring causal complexity. *Sociological Methods & Research* 38(1):71-101.
- Baumgartner, Michael, and Alrik Thiem. 2015. Model ambiguities in configurational comparative research. *Sociological Methods & Research*. DOI: 10.1177/0049124115610351.
- Braumoeller, Bear F., and Gary Goertz. 2000. The methodology of necessary conditions. *American Journal of Political Science* 44(4):844-58.
- Cooper, Barry, and Judith Glaesser. 2015. Qualitative Comparative Analysis, necessary conditions, and limited diversity: Some problematic consequences of Schneider and Wagemann's Enhanced Standard Analysis. *Field Methods*. DOI: 10.1177/1525822x15598974.
- Duşa, Adrian, and Alrik Thiem. 2014. *QCA: A package for Qualitative Comparative Analysis*. R package version 1.1-4. URL: <http://cran.r-project.org/package=QCA>.
- . 2015. Enhancing the minimization of Boolean and multivalued output functions with eQMC. *Journal of Mathematical Sociology* 39(2):92-108.
- Fiss, Peer C. 2007. A set-theoretic approach to organizational configurations. *Academy of Management Review* 32(4):1180-98.
- Goertz, Gary. 2003. The substantive importance of necessary condition hypotheses. In *Necessary conditions: Theory, methodology, and applications*, eds Gary Goertz and Harvey Starr, 65-94. Lanham: Rowman & Littlefield.
- Goertz, Gary, and James Mahoney. 2012. *A tale of two cultures: Qualitative and quantitative research in the social sciences*. Princeton, N.J.: Princeton University Press.
- Goertz, Gary, and Harvey Starr. eds. 2003. *Necessary conditions: Theory, methodology, and applications*. Lanham: Rowman & Littlefield.
- Hicks, Alexander. 1994. Qualitative Comparative Analysis and Analytical Induction: The case of the emergence of the social security state. *Sociological Methods & Research* 23(1):86-113.

- Lichbach, Mark I. 1981. Regime change: A test of structuralist and functionalist explanations. *Comparative Political Studies* 14(1):49-73.
- Lieberson, Stanley. 2004. Comments on the use and utility of QCA. *Qualitative Methods* 2(2):13-4.
- 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.
- McCluskey, Edward J. 1965. *Introduction to the theory of switching circuits*. Princeton: Princeton University Press.
- North, Douglass C., and Barry R. Weingast. 1989. Constitutions and commitment: The evolution of institutional governing public choice in seventeenth-century England. *Journal of Economic History* 49(4):803-32.
- Quine, Willard V. 1952. The problem of simplifying truth functions. *American Mathematical Monthly* 59(8):521-31.
- Ragin, Charles C. 1987. *The comparative method: Moving beyond qualitative and quantitative strategies*. Berkeley: University of California Press.
- . 2000. *Fuzzy-set social science*. Chicago: University of Chicago Press.
- . 2008. *Redesigning social inquiry: Fuzzy sets and beyond*. Chicago: University of Chicago Press.
- . 2009. Qualitative Comparative Analysis Using Fuzzy Sets (fsQCA). In *Configurational Comparative Methods: Qualitative Comparative Analysis (QCA) and related techniques*, eds. Benoît Rihoux and Charles C. Ragin, 87-121. London: SAGE.
- Rihoux, Benoît, and Charles C. Ragin. eds. 2009. *Configurational Comparative Methods: Qualitative Comparative Analysis (QCA) and related techniques*. London: SAGE.
- Rihoux, Benoît, and Gisèle De Meur. 2009. Crisp-set Qualitative Comparative Analysis (csQCA). In *Configurational Comparative Methods: Qualitative Comparative Analysis (QCA) and related techniques*, eds. Benoît Rihoux and Charles C. Ragin, 33-68. London: SAGE.

- Rihoux, Benoît, Priscilla Álamos-Concha, Damien Bol, Axel Marx, and Ilona Rezsöhazy. 2013. From niche to mainstream method? A comprehensive mapping of QCA applications in journal articles from 1984 to 2011. *Political Research Quarterly* 66(1):175-84.
- 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.
- . 2012. *Set-theoretic methods for the social sciences: A guide to Qualitative Comparative Analysis (QCA)*. Cambridge: Cambridge University Press.
- . 2013. Doing justice to logical remainders in QCA: Moving beyond the standard analysis. *Political Research Quarterly* 66(1):211-20.
- Sutton, John R. 1983. Social structure, institutions, and the legal status of children in the United States. *American Journal of Sociology* 88(5):915-47.
- Thiem, Alrik. 2014a. Navigating the complexities of Qualitative Comparative Analysis: Case numbers, necessity relations, and model ambiguities. *Evaluation Review* 38(6):487-513.
- . 2014b. Unifying Configurational Comparative Methods: Generalized-set Qualitative Comparative Analysis. *Sociological Methods & Research* 43(2):313-37.
- . 2015. Using Qualitative Comparative Analysis for identifying causal chains in configurational data: A methodological commentary on Baumgartner and Epple (2014). *Sociological Methods & Research* 44(4):723-36.
- Thiem, Alrik, and Adrian Duşa. 2013a. *Qualitative Comparative Analysis with R: A user's guide*. New York: Springer.
- . 2013b. QCA: A package for Qualitative Comparative Analysis. *The R Journal* 5(1):87-97.
- . 2013c. Boolean minimization in social science research: A review of current software for Qualitative Comparative Analysis (QCA). *Social Science Computer Review* 31(4):505-21.
- Thiem, Alrik, Michael Baumgartner, and Damien Bol. 2015. Still lost in translation! A correction of three misunderstandings between configurational comparativists and regressional analysts. *Comparative Political Studies*. DOI: 10.1177/0010414014565892.

Thomann, Eva. 2015. Is output performance all about the resources? A fuzzy-set Qualitative Comparative Analysis of street-level bureaucrats in Switzerland. *Public Administration* 93(1):177-94.

Wagemann, Claudius, and Carsten Q. Schneider. 2015. Transparency standards in Qualitative Comparative Analysis. *Qualitative & Multi-Method Research* 13(1):38-42.

Table 1 Extended truth table based on Table 1 in Schneider and Wagemann (2013, 213)

Row	D	U	L	I	G	Output	SA	IC ₁	ID	Cases
1	1	1	1	1	1	1				BE, CZ, NL, UK
2	1	0	1	0	1	1				FI, IE
3	1	0	1	1	1	0				FR, SE
4	0	0	1	0	1	0				EE
5	0	0	1	0	0	0				HU, PL
6	1	1	1	1	0	0				DE
7	1	0	1	1	0	0				AT
8	0	0	0	0	1	0				IT, RO
9	0	0	0	0	0	0				GR, PT, ES
10	0	0	0	1	0	?		✓	1	
11	0	0	0	1	1	?		✓	1,3,4	
12	0	0	1	1	0	?		✓	1,4,8	
13	0	0	1	1	1	?			3,4,8	
14	0	1	0	0	0	?		✓	1,2,5,	
15	0	1	0	0	1	?	✓	✓	1,2,3,5	
16	0	1	0	1	0	?		✓	1,4,5	
17	0	1	0	1	1	?	✓	✓	1,3,4,5	
18	0	1	1	0	0	?		✓	1,2,5,6	
19	0	1	1	0	1	?	✓		2,3,5,6	
20	0	1	1	1	0	?		✓	1,4,5	
21	0	1	1	1	1	?	✓		3,4,5	
22	1	0	0	0	0	?	✓	✓	1	
23	1	0	0	0	1	?	✓	✓	1	
24	1	0	0	1	0	?		✓	1	
25	1	0	0	1	1	?		✓	1	
26	1	0	1	0	0	?	✓	✓	1	
27	1	1	0	0	0	?	✓	✓	1,2	
28	1	1	0	0	1	?	✓	✓	1,2	
29	1	1	0	1	0	?		✓	1	
30	1	1	0	1	1	?	✓	✓	1	
31	1	1	1	0	0	?	✓	✓	1,2	
32	1	1	1	0	1	?	✓		2	

Table 2 Exhaustive list of minimally necessary conditions for Table 1

Condition	Inclusion	Coverage	Negation	ID
<i>LG</i>	0.915	0.793	$\sim L + \sim G$	1
<i>I + \sim U</i>	0.989	0.511	$\sim IU$	2
<i>D + \sim G</i>	0.912	0.579	$\sim DG$	3
<i>D + \sim I</i>	0.964	0.518	$\sim DI$	4
<i>D + \sim U</i>	0.964	0.506	$\sim DU$	5
<i>D + \sim L + I</i>	0.919	0.569	$\sim DL \sim I$	6
<i>D + U + I</i>	0.903	0.716	$\sim D \sim U \sim I$	7
<i>D + U + \sim L</i>	0.924	0.570	$\sim D \sim UL$	8

Supplement: Table S1 presents the studies included in the meta-analysis (column “Reference”), all 36 outcomes they have analyzed in total (column “Outcome ID”), the inclusion cut-off that was originally set in the analysis of necessity (column “Incl. cut-off (orig.)”) and the number of conditions they report to their readers (column “Conditions reported”).

Table S1 Reanalysis of necessity tests and COSO-Effect for 36 outcomes across 21 published QCA studies

Study	Outcome ID	Reference	Outcome	Incl. cut-off (orig.)	Conditions reported	All conditions at original cut-off	All conditions at 0.75 inclusion	QCA models	Models with COSO-Effect
1	1	Avdagic (2010)	SOCP (M1)	0.9	0	7	10	1	1
1	2		SOCP (M2)	0.9	0	6	10	4	4
1	3		SOCP (M3)	0.9	0	12	12	10	8
2	4	Bank, Richter, and Sunik (2015)	SURVIVAL	0.9	0	22	31	2	2
2	5		~SURVIVAL	0.9	0	34	23	12	12
3	6	Basedau and Richter (2014)	CWO	1.0	1	4	7	2	2
3	7		~CWO	1.0	0	5	16	1	1
4	8	Cebotari and Vink (2013)	PROTEST	0.9	1	24	26	1	1
4	9		~PROTEST	0.9	1	9	14	1	1
5	10	Da Roit and Weicht (2013)	MIGFAM	0.9	2	11	27	13	13
5	11		~MIGFAM	0.9	1	23	27	11	8
5	12		MIGFOR	0.9	4	26	51	11	8
5	13		~MIGFOR	0.9	0	37	43	13	13
6	14	Davidsson and Emmenegger (2013)	TWOTIER	0.9	1	3	6	2	1 ^a
7	15	Emmenegger (2011)	JSR	0.9	1	49	41	6	6
8	16	Epple, Gasser, Kersten, Nollert and Schief (2014)	D	0.9	1	17	18	1	1

8	17		~D	0.9	0	22	27	1	1
9	18	Fischer (2015)	DOM	0.9	0	4	8	1	1
10	19	Hamidov, Thiel and Zikos (2015)	MIC	0.9	0	2	4	^b	^b
11	20	Ishiyama and Batta (2012)	DPS	0.9	0	19	15	3	3
11	21		~DPS	0.9	0	11	10	3	3
12	22	Karlas (2012)	CONT	0.8	1	50	37	52	52
13	23	Lilliefeldt (2012)	BALANCE	0.9	0	253	103	^c	^c
13	24		~BALANCE	0.9	0	219	98	^c	^c
14	25	Mello (2012)	MP	^d	1	4	10	2	2
14	26		~MP	^d	0	9	20	1	1
15	27	Metelits (2009)	COERCE	0.8	1	2	2	1	1
16	28	Pahl-Wostl and Knieper (2014)	ADAP	0.9	1	15	19	4	4
16	29		~ADAP	0.9	0	21	14	1	1
17	30	Palm (2013)	IWS	0.9	0	9	10	10	10
17	31		~IWS	0.9	0	10	15	3	3
18	32	Park and Young (2015)	WM	0.95	0	23	21	4	4
19	33	Schneider and Makszin (2014)	LPI	^e	0	13	18	1	1
20	34	Thomann (2015)	PERF	0.9	0	50	31	4	4
20	35		~PERF	0.9	0	46	50	12	12
21	36	Verweij, Klijn, Edelenbos and Van Buuren (2013)	O	^d	0	5	5	1	1

^a no simplifying assumptions for one model; ^b saturated truth table; ^c number of models not derivable due to high complexity of PI chart; ^d not mentioned; ^e not mentioned, but assumed to have been 0.9 as suggested by one of the authors in a different publication (Schneider and Wagemann 2012:143).

References for Meta-Analysis

- Avdagic, Sabina. 2010. When are concerted reforms feasible? Explaining the emergence of social pacts in Western Europe. *Comparative Political Studies* 43(5):628-57.
- Bank, André, Thomas Richter, and Anna Sunik. 2015. Long-term monarchical survival in the Middle East: A configurational comparison, 1945-2012. *Democratization* 22(1):179-200.
- Basedau, Matthias, and Thomas Richter. 2014. Why do some oil exporters experience civil war but others do not? Investigating the conditional effects of oil. *European Political Science Review* 6(4):549-74.
- Cebotari, Victor, and Maarten P. Vink. 2013. A configurational analysis of ethnic protest in Europe. *International Journal of Comparative Sociology* 54(4):298-324.
- Da Roit, Barbara, and Bernhard Weicht. 2013. Migrant care work and care, migration and employment regimes: A fuzzy-set analysis. *Journal of European Social Policy* 23(5):469-486.
- Davidsson, Johan Bo, and Patrick Emmenegger. 2013. Defending the organisation, not the members: Unions and the reform of job security legislation in Western Europe. *European Journal of Political Research* 52(3):339-63.
- Emmenegger, Patrick. 2011. Job security regulations in Western Democracies: A fuzzy set analysis. *European Journal of Political Research* 50(3):336-64.
- Epple, Ruedi, Martin Gasser, Sarah Kersten, Michael Nollert, and Sebastian Schief. 2014. Institutions and gender time inequality: A fuzzy-set QCA of Swiss cantons. *Swiss Journal of Sociology* 40(2):259-78.
- Fischer, Manuel. 2015. Institutions and coalitions in policy processes: A cross-sectoral comparison. *Journal of Public Policy* 35(2):245-68.
- Hamidov, Ahmad, Andreas Thiel, and Dimitrios Zikos. 2015. Institutional design in transformation: A comparative study of local irrigation governance in Uzbekistan." *Environmental Science & Policy* 53(0):175-91.

- Ishiyama, John, and Anna Batta. 2012. The emergence of dominant political party systems in unrecognized states. *Communist and Post-Communist Studies* 45(1-2):123-30.
- Karlas, Jan. 2012. National parliamentary control of EU affairs: Institutional design after enlargement. *West European Politics* 35(5):1095-113.
- Lilliefeldt, Emelie. 2012. "Party and gender in Western Europe revisited: A fuzzy-set Qualitative Comparative Analysis of gender-balanced parliamentary parties. *Party Politics* 18(2):193-214.
- Mello, Patrick A. 2012. Parliamentary peace or partisan politics? Democracies' participation in the Iraq War. *Journal of International Relations and Development* 15(3):420-53.
- Metelits, Claire M. 2009. The consequences of rivalry: Explaining insurgent violence using fuzzy sets. *Political Research Quarterly* 62(4):673-84.
- Pahl-Wostl, Claudia, and Christian Knieper. 2014. The capacity of water governance to deal with the climate change adaptation challenge: Using fuzzy set Qualitative Comparative Analysis to distinguish between polycentric, fragmented and centralized regimes. *Global Environmental Change* 29(0):139-54.
- Palm, Trineke. 2013. Embedded in social cleavages: An explanation of the variation in timing of women's suffrage. *Scandinavian Political Studies* 36(1):1-22.
- Park, Sung Ho, and Kevin L. Young. 2015. Wage moderation in the public sector: The experiences of 11 EMU countries in the recent economic crisis, 2008–2010. *Economic and Industrial Democracy* 36(4):575-609.
- Schneider, Carsten Q., and Kristin Makszin. 2014. Forms of welfare capitalism and education-based participatory inequality. *Socio-Economic Review* 12(2):437-62.
- Verweij, Stefan, Erik-Hans Klijn, Jurian Edelenbos, and Arwin Van Buuren. 2013. What makes governance networks work? A fuzzy set Qualitative Comparative Analysis of 14 Dutch spatial planning projects. *Public Administration* 91(4):1035-55.