Applying qualitative comparative analysis (QCA) in poverty research

Dr. Mary Zhang

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School for Policy Studies
University of Bristol

I. What is QCA

- 1.1 Boolean algebra
- 1.2 Boolean minimisation
- 1.3 Necessary vs. sufficient conditions (I)
- 1.4 Veen diagram

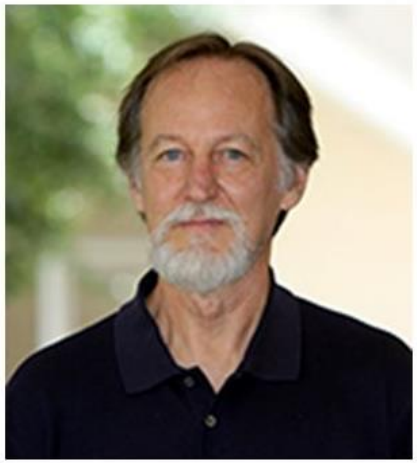
II. Crisp-set QCA

- 2.1 The truth table
- 2.2 Types of configurations
- 2.3 Resolve contradictory configurations

III. Fuzzy-set QCA

- 3.1 Calibration of fuzzy-set
- 3.2 Logical AND & OR
- 3.3 Necessary vs. sufficient conditions (II)

I. What is QCA



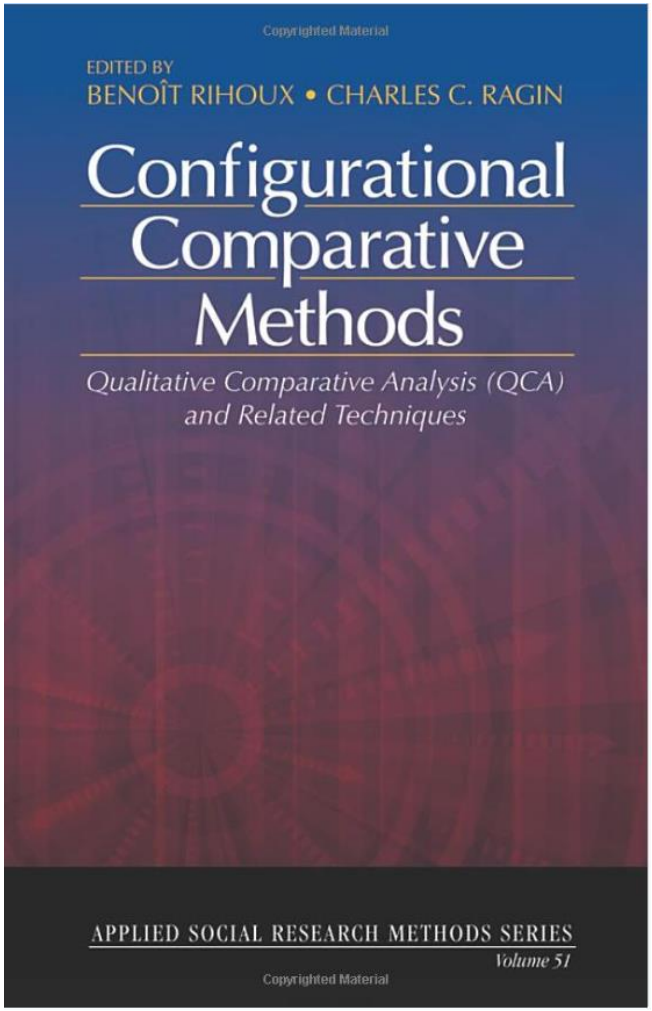
Charles C. Ragin

Chancellor's Professor of Sociology at the University of California, Irvine

Some Key QCA Works:

The Comparative Method (1987)
Fuzzy-Set Social Science (2000)
Redesigning Social Inquiry: Fuzzy Sets and Beyond (2008)

"…to ***identify patterns*** of multiple conjectural causation and ***simplify complex data structures*** in a logical and holistic manner" (Rihoux & de Meur, 2012, p.33)



References: Rihoux & de Meur (2008). Crisp-set Qualitative Comparative Analysis. In *Configurational Comparative Methods: Qualitative Comparative Analysis and Related Techniques*, SAGE Publications.

I. What is QCA

small number of cases

	Variable-orientated	Case-orientated	
	quantitative	qualitative	
causal competition	variables independent & evaluated against each	effect of one factor depending on presence/absence of others	**causal combination**
causal homogeneity	all variables work the same way in all cases	multiple paths leading to same outcome	**equifinality**

"using the basic principles of ***Boolean algebra***, QCA can identify, simplify and compare the ***combinations*** of conditions leading to a particular outcome" (Krook, 2010)

Reference: Krook (2010). Women's Representation in Parliament: A Qualitative Comparative Analysis. *Political Studies*.

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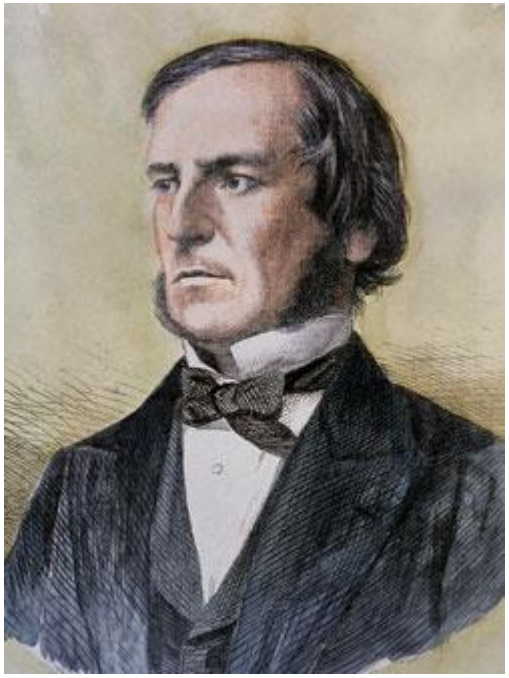
1.1 Boolean algebra

Boolean algebra conventions	
UPPERCASE	condition [A] is present/high/large
lowercase	condition [b] is absent/low/small
*	logical AND: [C*d] the presence of condition [C] AND the absence of condition [d]
+	logical OR: [c + D] the absence of condition [c] OR the presence of condition [D]



George Boole
19th Century British mathematician and logician

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1.2 Boolean minimisation

"if two Boolean expressions differ in ***only one*** causal condition yet produce the same outcome, then the causal condition that ***distinguishes*** the two expressions can be considered ***irrelevant*** and can be ***removed***" (Ragin, 1987, p.93)

* = logical AND
\+ = logical OR

UPPERCASE = PRESENCE
lowercase = absence

R * B * **I** + R * B * **i** → O

R * B → O

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1.3 Necessary vs. sufficient conditions (I)

A ***necessary*** condition is a condition that must be present for the outcome to occur, but its presence does not guarantee that occurrence.

A ***sufficient*** condition is a condition that is sufficient for an outcome, if the outcome always occurs when the condition (or combination of conditions) is present.

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1.4 Veen diagram: visualisation of Boolean minimisation

conditions	possibilities	
R	RIGHT (1)	not-right (0)
B	BELOW (1)	not-below (0)
I	INSIDE (1)	not-inside (0)

$$R * B \rightarrow O$$

all possible combinations (2 X 2 X 2 = 8)				
caseid	**R**	**B**	**I**	**O**
1	0	0	0	
2	1	0	0	
3	0	0	1	
4	1	0	1	
5	0	1	1	
6	0	1	0	
7	1	1	1	
8	1	1	0	

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2	1	0	0	0
3	0	0	1	0
4	1	0	1	0
5	0	1	1	0
6	0	1	0	0
7	1	1	1	1
8	1	1	0	1

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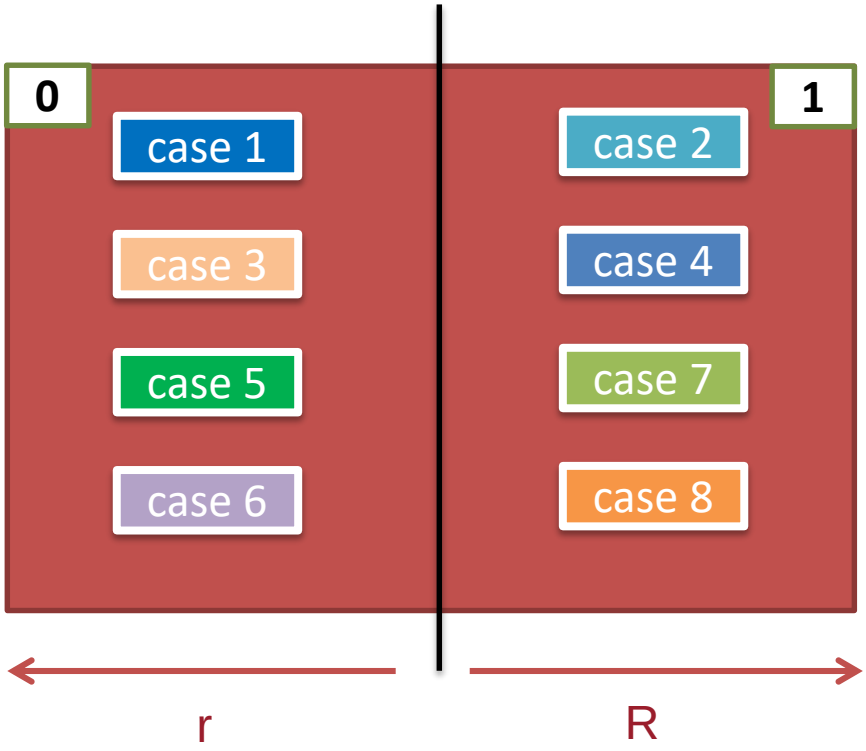

all possible combinations (2 X 2 X 2 = 8)	
caseid	**R**
1	0
2	1
3	0
4	1
5	0
6	0
7	1
8	1

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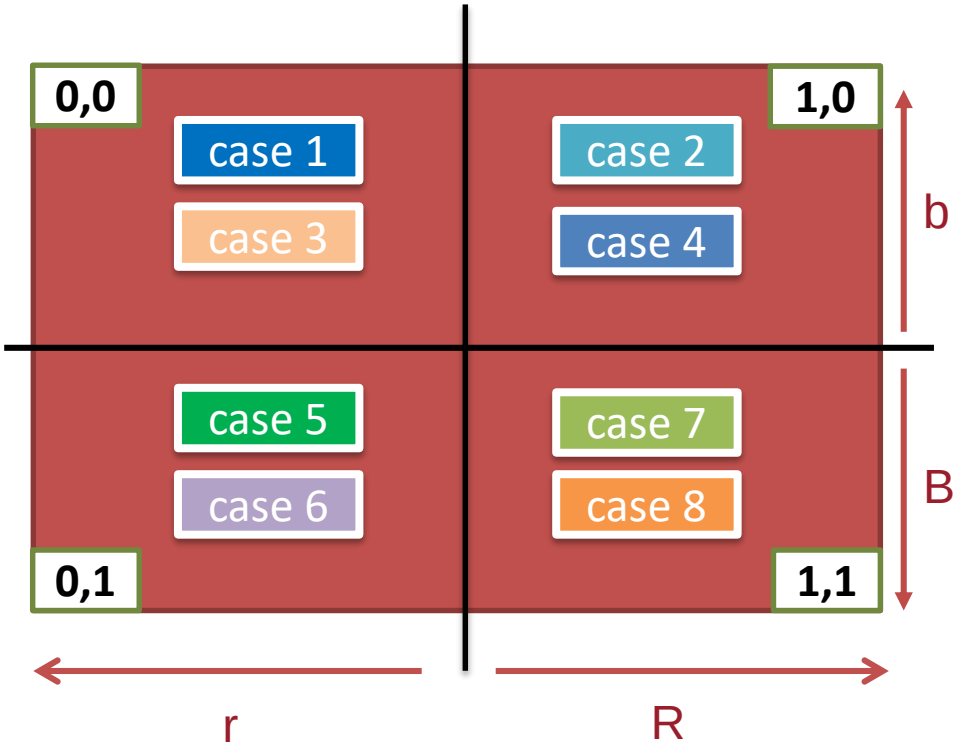

all possible combinations (2 X 2 X 2 = 8)		
caseid	**R**	**B**
1	0	0
2	1	0
3	0	0
4	1	0
5	0	1
6	0	1
7	1	1
8	1	1

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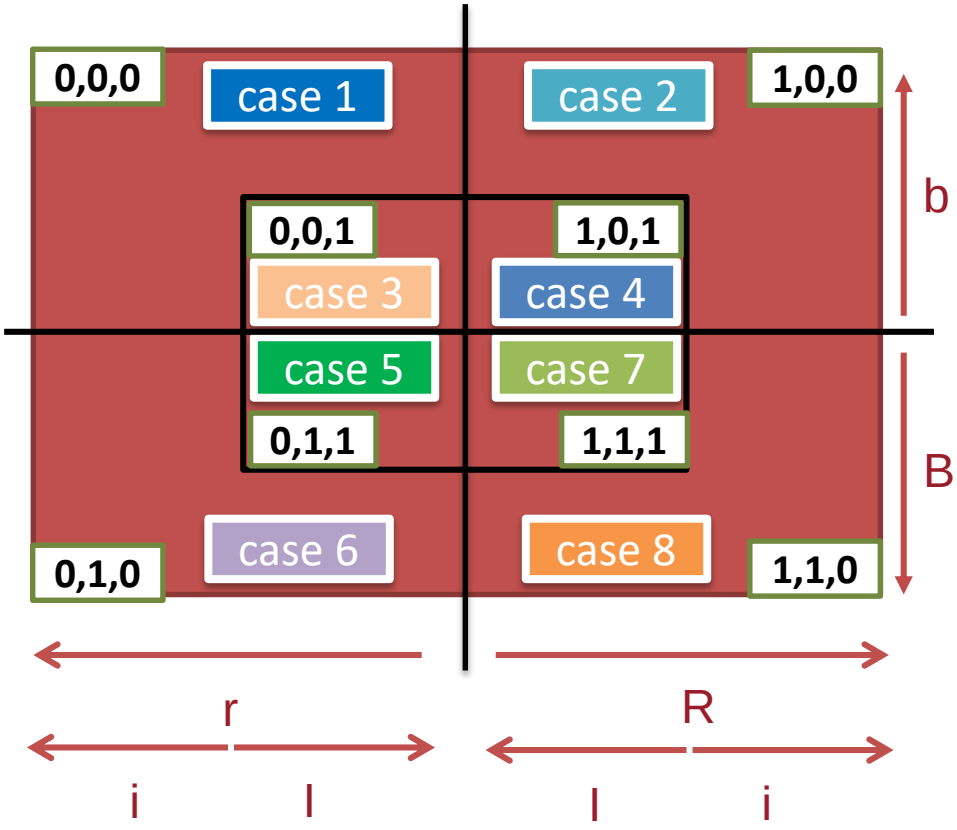

all possible combinations (2 X 2 X 2 = 8)			
caseid	**R**	**B**	**I**
1	0	0	0
2	1	0	0
3	0	0	1
4	1	0	1
5	0	1	1
6	0	1	0
7	1	1	1
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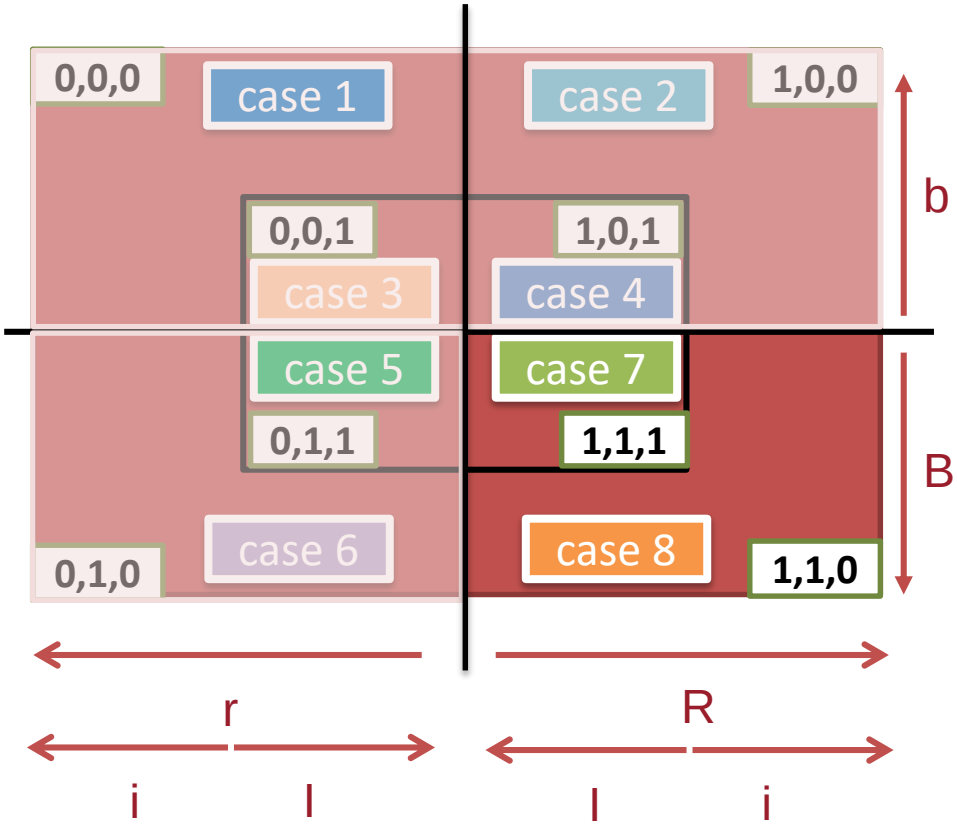

all possible combinations (2 X 2 X 2 = 8)				
caseid	**R**	**B**	**I**	**O**
1	0	0	0	0
2	1	0	0	0
3	0	0	1	0
4	1	0	1	0
5	0	1	1	0
6	0	1	0	0
7	1	1	1	1
8	1	1	0	1

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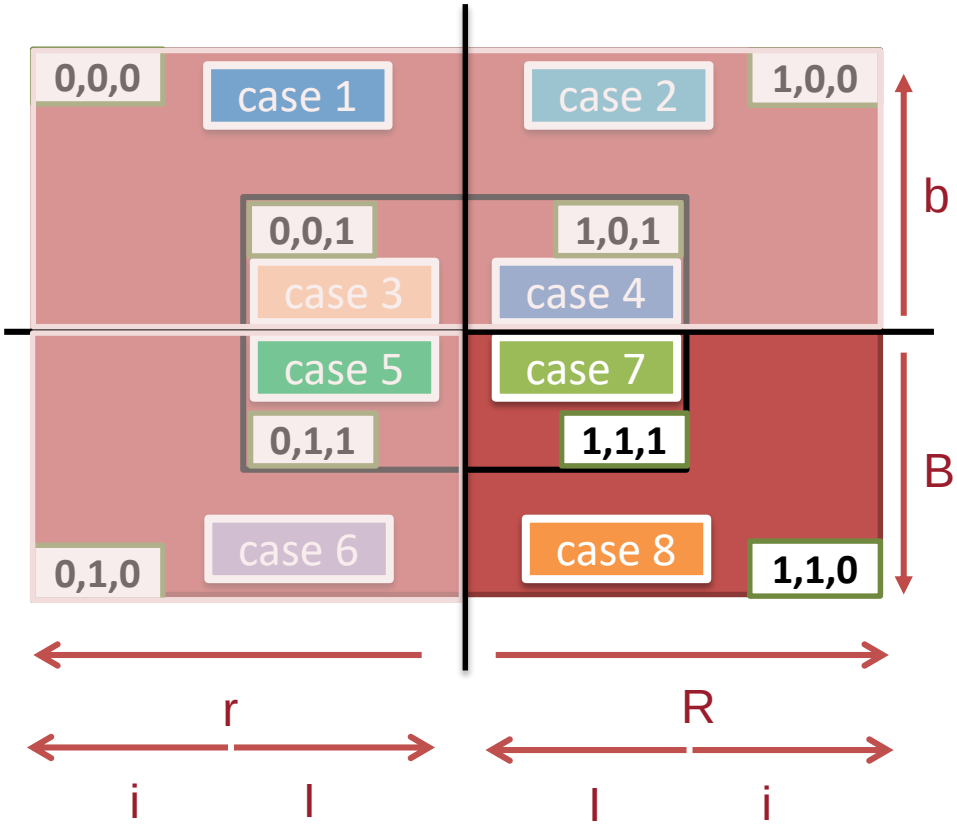

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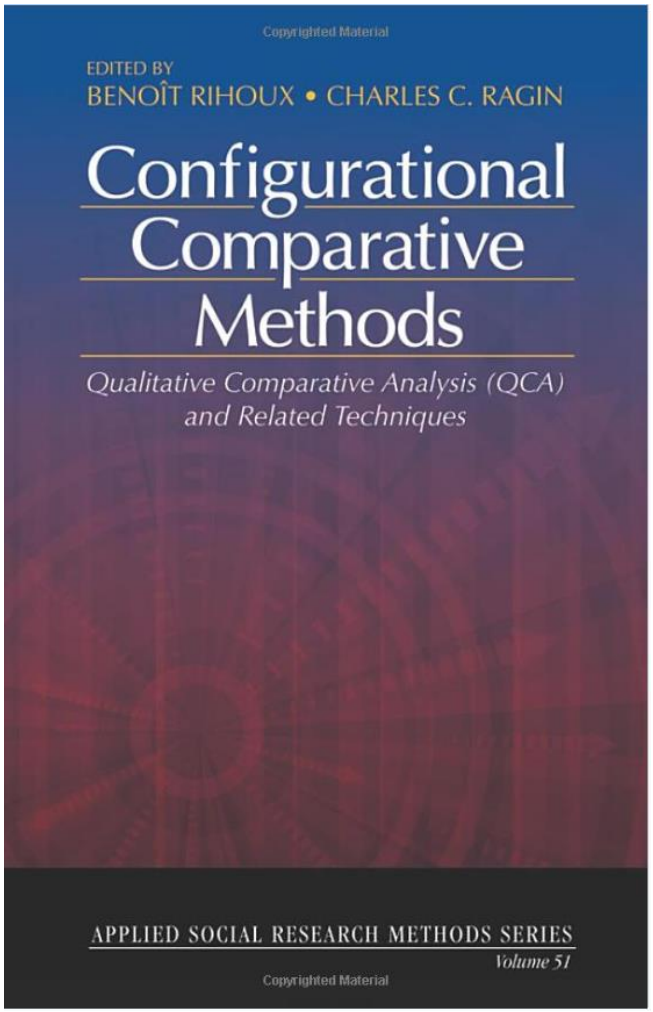
Why is it that some democratic systems in Europe survived during the inter-war period, while others collapsed?



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GNPCAP — **Gross National Product/Capita (ca. 1930)**

URBANIZA — **Urbanisation (% population in towns with 20,000 + inhabitants)**

LITERACY — **% Literacy**

INDLAB — **% Industrial Labour Force**

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CASE	GNPCAP	URBANIZA	LITERACY	INDLAB	SURVIVAL
AUS: Austria	720	33.4	98	33.4	0.05
BEL: Belgium	1098	60.5	94.4	48.9	0.95
CZE: Czechoslovakia	568	69.0	95.9	37.4	0.89
EST: Estonia	468	28.5	95	14.0	0.12
FIN: Finland	590	22.0	99.1	22.0	0.77
FRA: France	983	21.2	96.2	34.8	0.95
GER: Germany	795	56.5	98.0	40.4	0.05
GRE: Greece	390	31.1	59.2	28.1	0.06
HUN: Hungary	424	36.3	85.0	21.6	0.42
IRE: Ireland	662	25.0	95.0	14.5	0.92
ITA: Italy	517	31.4	72.1	29.6	0.05
NET: Netherlands	1008	78.8	99.9	39.3	0.95
POL: Poland	350	37.0	76.9	11.2	0.12
POR: Portugal	320	15.3	38.0	23.1	0.05
ROM: Romania	331	21.9	61.8	12.2	0.21
SPA: Spain	367	43.0	55.6	25.2	0.06
SWE: Sweden	897	34.0	99.9	32.3	0.95
UK: United Kingdom	1038	74.0	99.9	49.9	0.95

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CASE	GNPCAP: 600	URBANIZA: 50	LITERACY: 75	INDLAB: 30	SURVIVAL: 0.5
AUS: Austria	720	33.4	98	33.4	0.05
BEL: Belgium	1098	60.5	94.4	48.9	0.95
CZE: Czechoslovakia	568	69.0	95.9	37.4	0.89
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CASE	GNPCAP: 600	URBANIZA: 50	LITERACY: 75	INDLAB: 30	SURVIVAL: 0.5
AUS: Austria	1	0	1	1	0
BEL: Belgium	1	1	1	1	1
CZE: Czechoslovakia	0	1	1	1	1
EST: Estonia	0	0	1	0	0
FIN: Finland	0	0	1	0	1
FRA: France	1	0	1	1	1
GER: Germany	1	1	1	1	0
GRE: Greece	0	0	0	0	0
HUN: Hungary	0	0	1	0	0
IRE: Ireland	1	0	1	0	1
ITA: Italy	0	0	0	0	0
NET: Netherlands	1	1	1	1	1
POL: Poland	0	0	1	0	0
POR: Portugal	0	0	0	0	0
ROM: Romania	0	0	0	0	0
SPA: Spain	0	0	0	0	0
SWE: Sweden	1	0	1	1	1
UK: United Kingdom	1	1	1	1	1

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AUS: Austria	1	0	1	1	0
BEL: Belgium	1	1	1	1	1
CZE: Czechoslovakia	0	1	1	1	1
EST: Estonia	0	0	1	0	0
FIN: Finland	0	0	1	0	1
FRA: France	1	0	1	1	1
GER: German	1	1	1	1	0
GRE: Greece	0	0	0	0	0
HUN: Hungary	0	0	1	0	0
IRE: Ireland	1	0	1	0	1
ITA: Italy	0	0	0	0	0
NET: Netherlands	1	1	1	1	1
POL: Poland	0	0	1	0	0
POR: Portugal	**0**	**0**	**0**	**0**	**0**
ROM: Romania	0	0	0	0	0
SPA: Spain	0	0	0	0	0
SWE: Sweden	1	0	1	1	1
UK: United Kingdom	**1**	**1**	**1**	**1**	**1**

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CASE	GNPCAP	URBANIZA	LITERACY	INDLAB
SWE: Sweden; FRA: France; AUS: Austria	1	0	1	1
FIN: Finland; HUN: Hungary; POL: Poland; EST: Estonia	0	0	1	0
BEL: Belgium; NET: Netherlands; UK: United Kingdom; GER: Germany	1	1	1	1
CZE: Czechoslovakia	0	1	1	1
ITA: Italy; ROM: Romania; POR: Portugal; SPA: Spain; GRE: Greece	0	0	0	0
IRE: Ireland	1	0	1	0

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2.2 Types of configurations

CASE	GNPCAP	URBANIZA	LITERACY	INDLAB	TYPE
SWE: Sweden; FRA: France; AUS: Austria	1	0	1	1	C
FIN: Finland; HUN: Hungary; POL: Poland; EST: Estonia	0	0	1	0	C
BEL: Belgium; NET: Netherlands; UK: United Kingdom; GER: Germany	1	1	1	1	C
CZE: Czechoslovakia	0	1	1	1	1
ITA: Italy; ROM: Romania; POR: Portugal; SPA: Spain; GRE: Greece	0	0	0	0	0
IRE: Ireland	1	0	1	0	1

1 configuration **presence of an outcome**

0 configuration **absence of an outcome**

C configuration **both presence and absence of an outcome**

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2.3 Resolve contradictory configurations

A. Add one or more conditions

B. Remove one or more conditions

C. Adjust the threshold of dichotomisation

D. Re-examine the outcome

E. Re-examine the cases involved

F. Re-code all contradictory configurations as [0] outcome

G. Re-code all contradictory configurations as [1] outcome if it fits the majority of cases

Several iterations may be needed to obtain a contradiction-free truth table!

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2.2 Types of configurations

CASE	GNPCAP	URBANIZA	LITERACY	INDLAB	TYPE
SWE: Sweden; FRA: France; AUS: Austria	1	0	1	1	C
FIN: Finland; HUN: Hungary; POL: Poland; EST: Estonia	0	0	1	0	C
BEL: Belgium; NET: Netherlands; UK: United Kingdom; **GER: Germany**	1	1	1	1	C → 1
CZE: Czechoslovakia	0	1	1	1	1
ITA: Italy; ROM: Romania; POR: Portugal; SPA: Spain; GRE: Greece	0	0	0	0	0
IRE: Ireland	1	0	1	0	1

1 configuration — **presence of an outcome**

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C configuration — **both presence and absence of an outcome**

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LITERACY	% Literacy	INDLAB	% Industrial Labour Force

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LITERACY	% Literacy
INDLAB	% Industrial Labour Force
GOVSTAB	Governmental stability: 10+ cabinets having governed during the period under investigation

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CASE	GNPCAP: 600	URBANIZA: 50	LITERACY: 75	INDLAB: 30	GOVSTAB: 10	SURVIVAL: 0.5
AUS: Austria	1	0	1	1	0	0
BEL: Belgium	1	1	1	1	1	1
CZE: Czechoslovakia	0	1	1	1	1	1
EST: Estonia	0	0	1	0	1	0
FIN: Finland	0	0	1	0	1	1
FRA: France	1	0	1	1	1	1
GER: Germany	1	1	1	1	0	0
GRE: Greece	0	0	0	0	0	0
HUN: Hungary	0	0	1	0	0	0
IRE: Ireland	1	0	1	0	1	1
ITA: Italy	0	0	0	0	1	0
NET: Netherlands	1	1	1	1	1	1
POL: Poland	0	0	1	0	0	0
POR: Portugal	0	0	0	0	0	0
ROM: Romania	0	0	0	0	1	0
SPA: Spain	0	0	0	0	0	0
SWE: Sweden	1	0	1	1	1	1
UK: United Kingdom	1	1	1	1	1	1

Reference: Ragin (2008). Qualitative Comparative Analysis using Fuzzy Sets (fsQCA). In *Configurational Comparative Methods: Qualitative Comparative Analysis and Related Techniques.* SAGE Publication.

CASE	GNPC AP	URBA NIZA	LITER ACY	INDL AB	TYPE
SWE: Sweden; FRA: France; AUS: Austria	1	0	1	1	C
FIN: Finland; HUN: Hungary; POL: Poland; EST: Estonia	0	0	1	0	C
BEL: Belgium; NET: Netherlands; UK: United Kingdom; GER: Germany	1	1	1	1	C
CZE: Czechoslovakia	0	1	1	1	1
ITA: Italy; ROM: Romania; POR: Portugal; SPA: Spain; GRE: Greece	0	0	0	0	0
IRE: Ireland	1	0	1	0	1

CASE	GNPC AP	URBA NIZA	LITER ACY	INDLA B	GOVS TAB	TYPE
AUS: Austria	1	0	1	1	0	0
BEL: Belgium; NET: Netherlands; UK: United Kingdom	1	1	1	1	1	1
CZE: Czechoslovakia	0	1	1	1	1	1
EST: Estonia; FIN: Finland	0	0	1	0	1	C
SWE: Sweden; FRA: France;	1	0	1	1	1	1
GER: Germany	1	1	1	1	0	0
POR: Portugal; SPA: Spain; GRE: Greece	0	0	0	0	0	0
HUN: Hungary; POL: Poland	0	0	1	0	0	0
IRE: Ireland	1	0	1	0	1	1
ITA: Italy; ROM: Romania	0	0	0	0	1	0

1 configuration **presence of an outcome**

0 configuration **absence of an outcome**

C configuration **both presence and absence of an outcome**

2.3 Resolve contradictory configurations

A. **Add one or more conditions**

B. Remove one or more conditions

C. **Adjust the threshold of dichotomisation**

D. Re-examine the outcome

E. Re-examine the cases involved

F. Re-code all contradictory configurations as [0] outcome

G. Re-code all contradictory configurations as [1] outcome if it fits the majority of cases

Several iterations may be needed to obtain a contradiction-free truth table!

CASE	GNPCAP: 550	URBANIZA: 50	LITERACY: 75	INDLAB: 30	GOVSTAB: 10	SURVIVAL: 0.5
AUS: Austria	720	33.4	98	33.4	10	0.05
BEL: Belgium	1098	60.5	94.4	48.9	4	0.95
CZE: Czechoslovakia	568	69.0	95.9	37.4	6	0.89
EST: Estonia	468	28.5	95	14.0	6	0.12
FIN: Finland	590	22.0	99.1	22.0	9	0.77
FRA: France	983	21.2	96.2	34.8	5	0.95
GER: Germany	795	56.5	98.0	40.4	11	0.05
GRE: Greece	390	31.1	59.2	28.1	10	0.06
HUN: Hungary	424	36.3	85.0	21.6	13	0.42
IRE: Ireland	662	25.0	95.0	14.5	5	0.92
ITA: Italy	517	31.4	72.1	29.6	9	0.05
NET: Netherlands	1008	78.8	99.9	39.3	2	0.95
POL: Poland	350	37.0	76.9	11.2	21	0.12
POR: Portugal	320	15.3	38.0	23.1	19	0.05
ROM: Romania	331	21.9	61.8	12.2	7	0.21
SPA: Spain	367	43.0	55.6	25.2	12	0.06
SWE: Sweden	897	34.0	99.9	32.3	6	0.95
UK: United Kingdom	1038	74.0	99.9	49.9	4	0.95

Reference: Ragin (2008). Qualitative Comparative Analysis using Fuzzy Sets (fsQCA). In *Configurational Comparative Methods: Qualitative Comparative Analysis and Related Techniques.* SAGE Publication.

CASE	GNPCAP: 550	URBANIZA: 50	LITERACY: 75	INDLAB: 30	GOVSTAB: 10	SURVIVAL
AUS: Austria	1	0	1	1	0	0
BEL: Belgium	1	1	1	1	1	1
CZE: Czechoslovakia	1	1	1	1	1	1
EST: Estonia	0	0	1	0	1	0
FIN: Finland	1	0	1	0	1	1
FRA: France	1	0	1	1	1	1
GER: Germany	1	1	1	1	0	0
GRE: Greece	0	0	0	0	0	0
HUN: Hungary	0	0	1	0	0	0
IRE: Ireland	1	0	1	0	1	1
ITA: Italy	0	0	0	0	1	0
NET: Netherlands	1	1	1	1	1	1
POL: Poland	0	0	1	0	0	0
POR: Portugal	0	0	0	0	0	0
ROM: Romania	0	0	0	0	1	0
SPA: Spain	0	0	0	0	0	0
SWE: Sweden	1	0	1	1	1	1
UK: United Kingdom	1	1	1	1	1	1

Reference: Ragin (2008). Qualitative Comparative Analysis using Fuzzy Sets (fsQCA). In *Configurational Comparative Methods: Qualitative Comparative Analysis and Related Techniques.* SAGE Publication.

CASE	GNPC AP	URBA NIZA	LITER ACY	INDL AB	GOVS TAB	TYPE
AUS: Austria	1	0	1	1	0	0
BEL: Belgium; NET: Netherlands; UK: United Kingdom	1	1	1	1	1	1
CZE: Czechoslovakia	0	1	1	1	1	1
EST: Estonia; FIN: Finland	0	0	1	0	1	C
SWE: Sweden; FRA: France;	1	0	1	1	1	1
GER: Germany	1	1	1	1	0	0
POR: Portugal; SPA: Spain; GRE: Greece	0	0	0	0	0	0
HUN: Hungary; POL: Poland	0	0	1	0	0	0
IRE: Ireland	1	0	1	0	1	1
ITA: Italy; ROM: Romania	0	0	0	0	1	0

CASE	GNPC AP	URBA NIZA	LITER ACY	INDL AB	GOVS TAB	TYPE
AUS: Austria	1	0	1	1	0	0
BEL: Belgium; CZE: Czechoslovakia NET: Netherlands; UK: United Kingdom	1	1	1	1	1	1
EST: Estonia	0	0	1	0	1	0
SWE: Sweden; FRA: France;	1	0	1	1	1	1
GER: Germany	1	1	1	1	0	0
POR: Portugal; SPA: Spain; GRE: Greece	0	0	0	0	0	0
HUN: Hungary; POL: Poland	0	0	1	0	0	0
IRE: Ireland; FIN: Finland	1	0	1	0	1	1
ITA: Italy; ROM: Romania	0	0	0	0	1	0

1 configuration presence of an outcome

0 configuration absence of an outcome

C configuration both presence and absence of an outcome

2.3 Resolve contradictory configurations

A. Add one or more conditions

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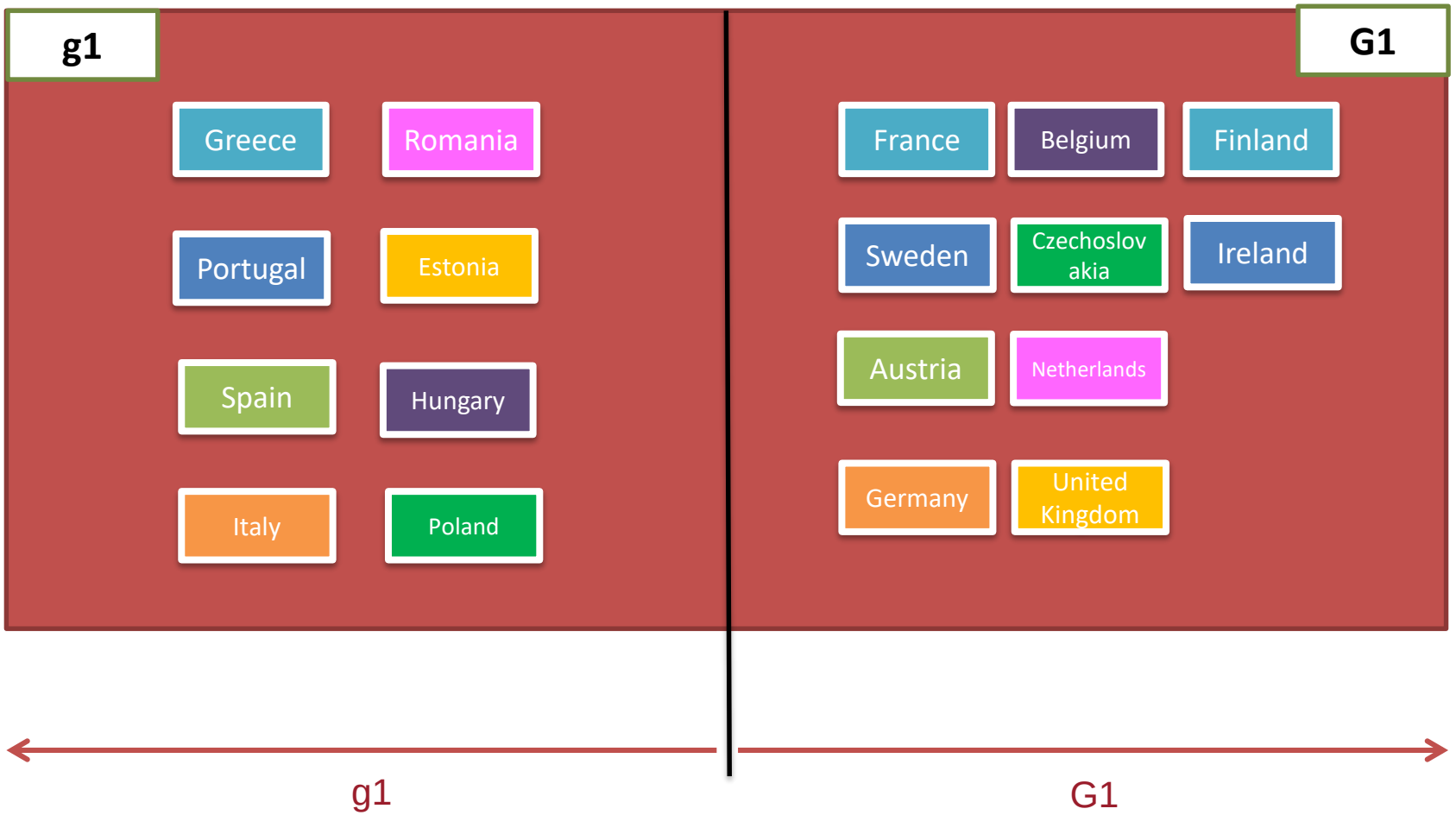
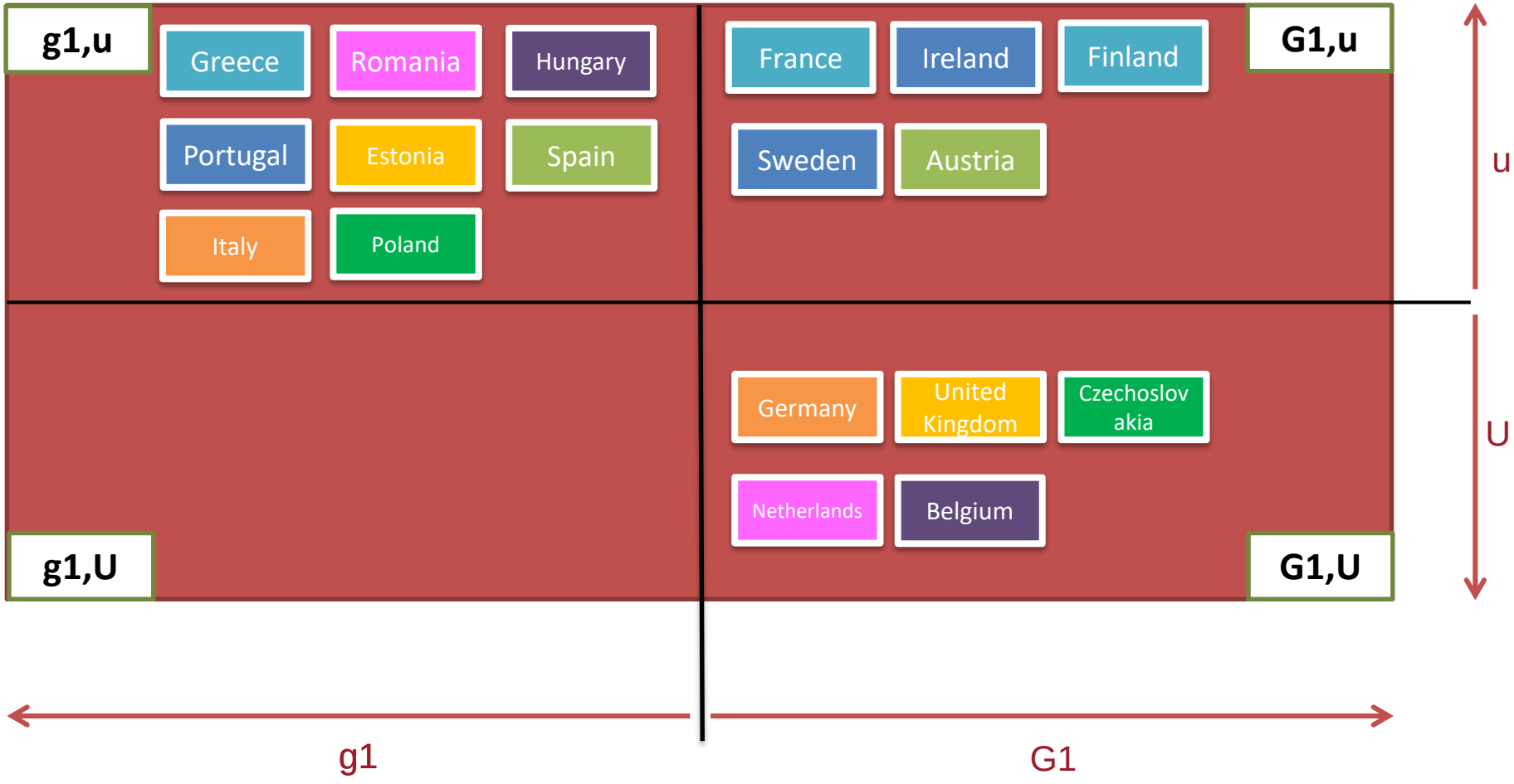
Reference: Ragin (2008). Qualitative Comparative Analysis using Fuzzy Sets (fsQCA). In *Configurational Comparative Methods: Qualitative Comparative Analysis and Related Techniques.* SAGE Publication.

GNPCAP (G1)

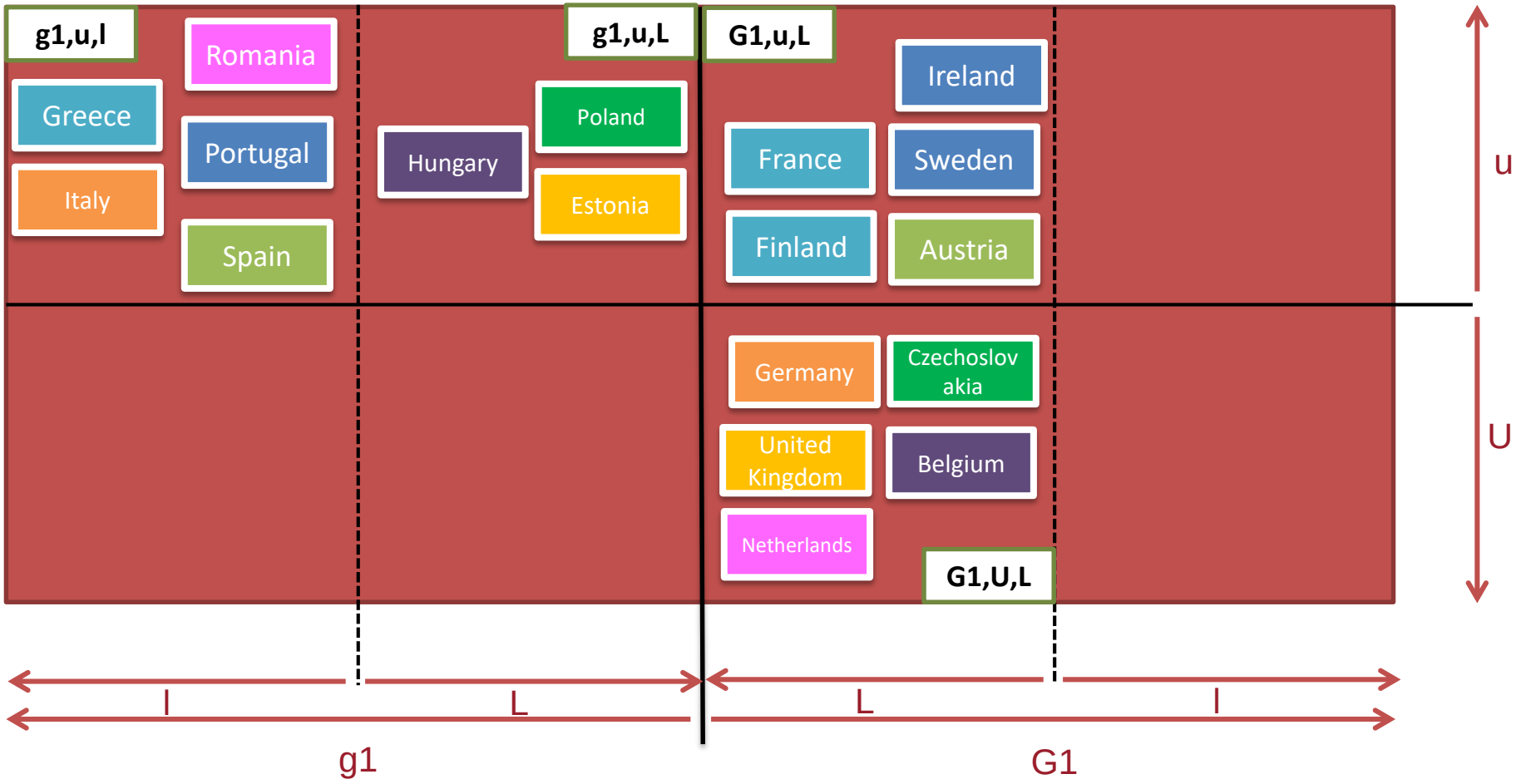

g1
Greece
Romania
Portugal
Estonia
Spain
Hungary
Italy
Poland
G1
France
Belgium
Finland
Sweden
Czechoslovakia
Ireland
Austria
Netherlands
Germany
United Kingdom
g1
G1

GNPCAP (G1)	URBANIZA (U)

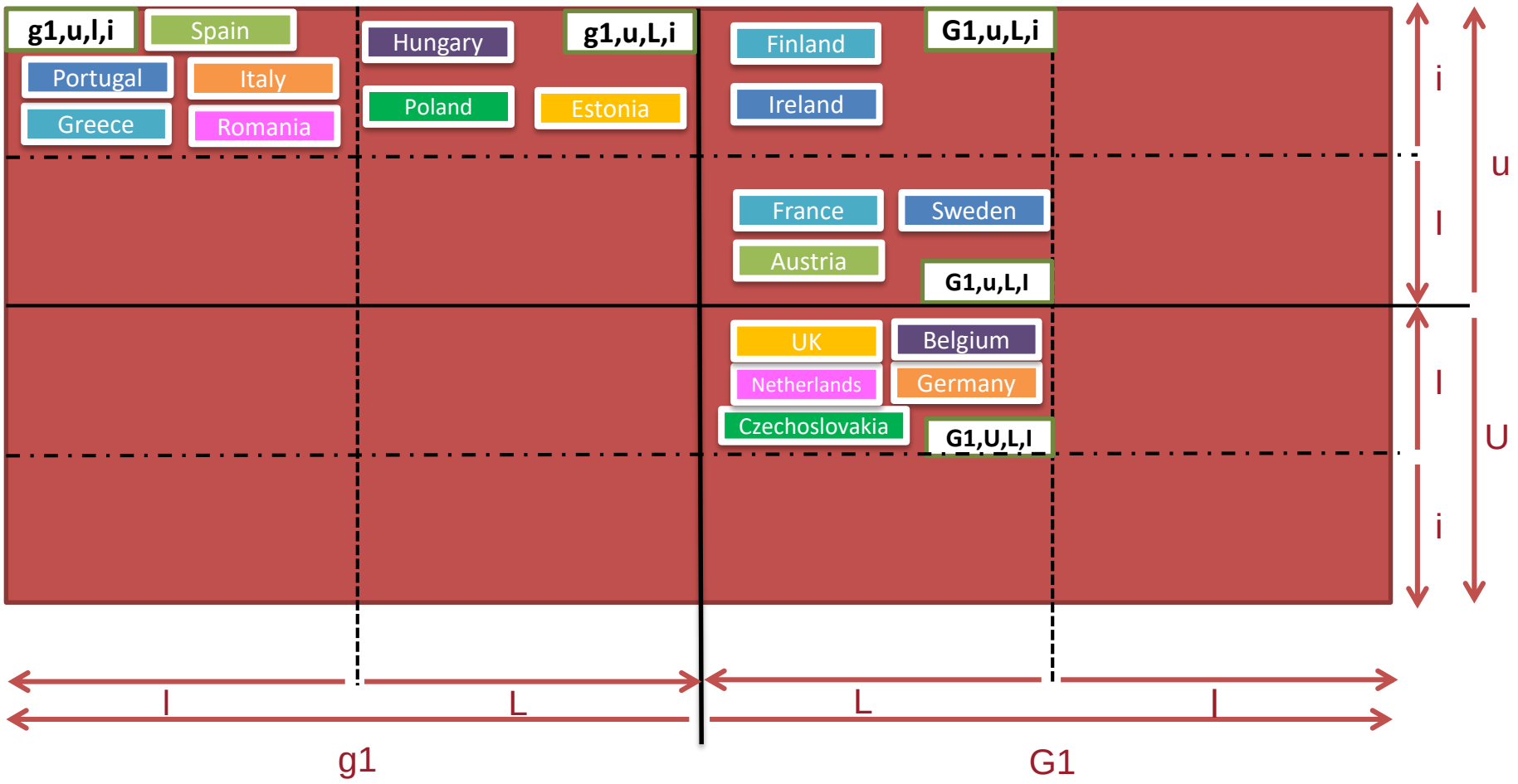


Reference: Ragin (2008). Qualitative Comparative Analysis using Fuzzy Sets (fsQCA). In *Configurational Comparative Methods: Qualitative Comparative Analysis and Related Techniques.* SAGE Publication.

GNPCAP (G1)	URBANIZA (U)	LITERACY (L)

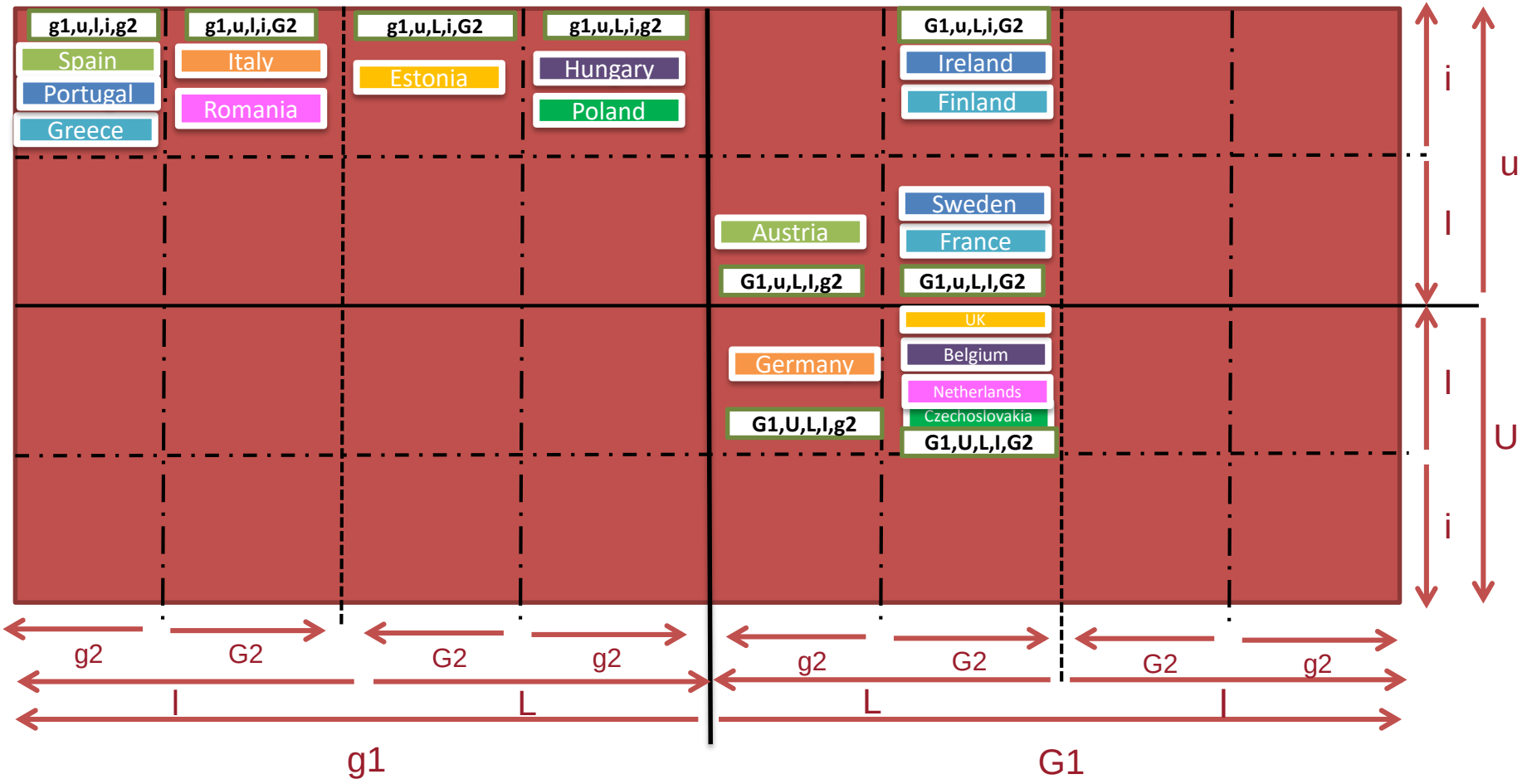


GNPCAP (G1)	URBANIZA (U)	LITERACY (L)	INDLAB (I)



Reference: Ragin (2008). Qualitative Comparative Analysis using Fuzzy Sets (fsQCA). In *Configurational Comparative Methods: Qualitative Comparative Analysis and Related Techniques.* SAGE Publication.

GNPCAP (G1)	URBANIZA (U)	LITERACY (L)	INDLAB (I)	GOVSTAB (G2)



Reference: Ragin (2008). Qualitative Comparative Analysis using Fuzzy Sets (fsQCA). In *Configurational Comparative Methods: Qualitative Comparative Analysis and Related Techniques.* SAGE Publication.

GNPCAP (G1)	URBANIZA (U)	LITERACY (L)	INDLAB (I)	GOVSTAB (G2)

SURVIVED [1]

G1,u,L,i,G2

Ireland

Finland

Sweden

France

G1,u,L,I,G2

UK

Belgium

Netherlands

Czechoslovakia

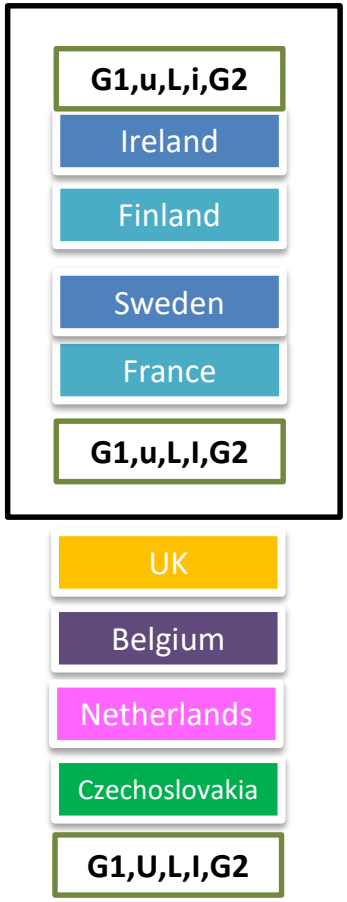
G1,U,L,I,G2

Reference: Ragin (2008). Qualitative Comparative Analysis using Fuzzy Sets (fsQCA). In *Configurational Comparative Methods: Qualitative Comparative Analysis and Related Techniques.* SAGE Publication.

GNPCAP (G1)	URBANIZA (U)	LITERACY (L)	INDLAB (I)	GOVSTAB (G2)

GNPCAP * urbaniza * LITERACY * GOVSTAB
→ SURVIVAL

SURVIVED [1]

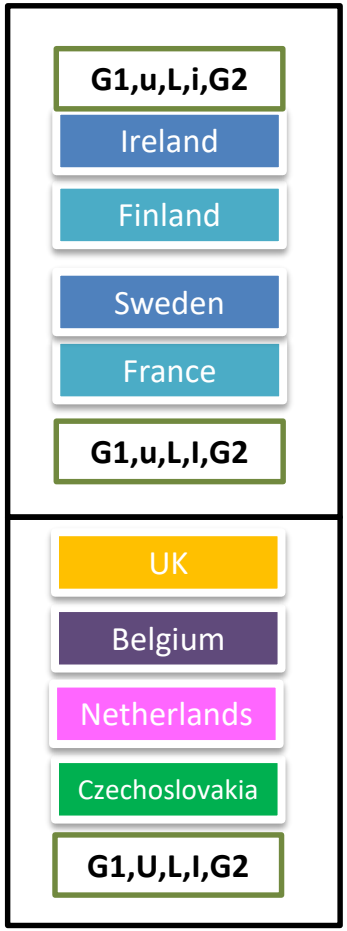


GNPCAP (G1)	URBANIZA (U)	LITERACY (L)	INDLAB (I)	GOVSTAB (G2)

GNPCAP * urbaniza * LITERACY * GOVSTAB
→ SURVIVAL

SURVIVED [1]

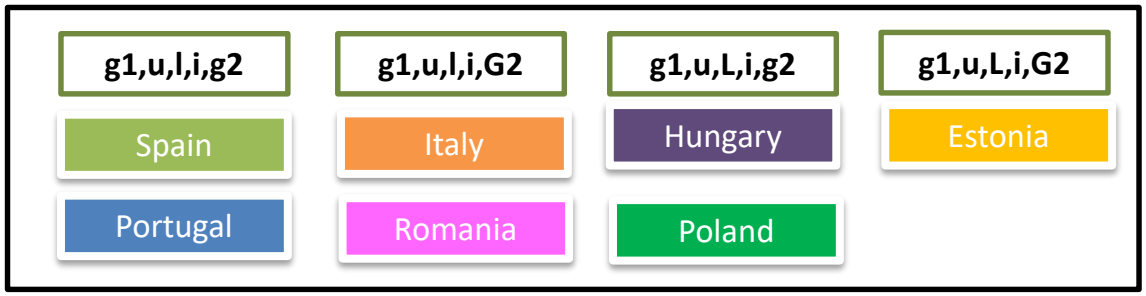
GNPCAP * URBANIZA * LITERACY * INDLAB * GOVSTAB
→ SURVIVAL



Do not expect to find perfect causal symmetry!

Reference: Ragin (2008). Qualitative Comparative Analysis using Fuzzy Sets (fsQCA). In *Configurational Comparative Methods: Qualitative Comparative Analysis and Related Techniques.* SAGE Publication.

GNPCAP (G1)	URBANIZA (U)	LITERACY (L)	INDLAB (I)	GOVSTAB (G2)



gnpcap * urbaniza * indlab
→ survival

breakdown [0]

G1,u,L,I,g2
Austria

Germany
G1,U,L,I,g2

GNPCAP (G1)	URBANIZA (U)	LITERACY (L)	INDLAB (I)	GOVSTAB (G2)

g1,u,l,i,g2	g1,u,l,i,G2	g1,u,L,i,g2	g1,u,L,i,G2
Spain	Italy	Hungary	Estonia
Portugal	Romania	Poland	

gnpcap * urbaniza * indlab
→ survival

GNPCAP * LITERACY *
INDLAB * govstab
→ survival

G1,u,L,I,g2
Austria
Germany
G1,U,L,I,g2

breakdown [0]

Reference: Ragin (2008). Qualitative Comparative Analysis using Fuzzy Sets (fsQCA). In *Configurational Comparative Methods: Qualitative Comparative Analysis and Related Techniques.* SAGE Publication.

I. What is QCA

- 1.1 Boolean algebra
- 1.2 Boolean minimisation
- 1.3 Necessary vs. sufficient conditions (I)
- 1.4 Veen diagram

II. Crisp-set QCA

- 2.1 The truth table
- 2.2 Types of configurations
- 2.3 Resolve contradictory configurations

III. Fuzzy-set QCA

- 3.1 Calibration of fuzzy-set
- 3.2 Logical AND & OR
- 3.3 Necessary vs. sufficient conditions (II)

III. Fuzzy-set QCA

What if we have continuous variables and do NOT want to dichotomise?

CASE	GNPCAP	URBANIZA	LITERACY	INDLAB	GOVSTAB	SURVIVAL
AUS: Austria	720	33.4	98	33.4	10	0.05
BEL: Belgium	1098	60.5	94.4	48.9	4	0.95
CZE: Czechoslovakia	568	69.0	95.9	37.4	6	0.89
EST: Estonia	468	28.5	95	14.0	6	0.12
FIN: Finland	590	22.0	99.1	22.0	9	0.77
FRA: France	983	21.2	96.2	34.8	5	0.95
GER: Germany	795	56.5	98.0	40.4	11	0.05
GRE: Greece	390	31.1	59.2	28.1	10	0.06
HUN: Hungary	424	36.3	85.0	21.6	13	0.42
IRE: Ireland	662	25.0	95.0	14.5	5	0.92
ITA: Italy	517	31.4	72.1	29.6	9	0.05
NET: Netherlands	1008	78.8	99.9	39.3	2	0.95
POL: Poland	350	37.0	76.9	11.2	21	0.12
POR: Portugal	320	15.3	38.0	23.1	19	0.05
ROM: Romania	331	21.9	61.8	12.2	7	0.21
SPA: Spain	367	43.0	55.6	25.2	12	0.06
SWE: Sweden	897	34.0	99.9	32.3	6	0.95
UK: United Kingdom	1038	74.0	99.9	49.9	4	0.95

Reference: Ragin (2008). Qualitative Comparative Analysis using Fuzzy Sets (fsQCA). In *Configurational Comparative Methods: Qualitative Comparative Analysis and Related Techniques.* SAGE Publication.

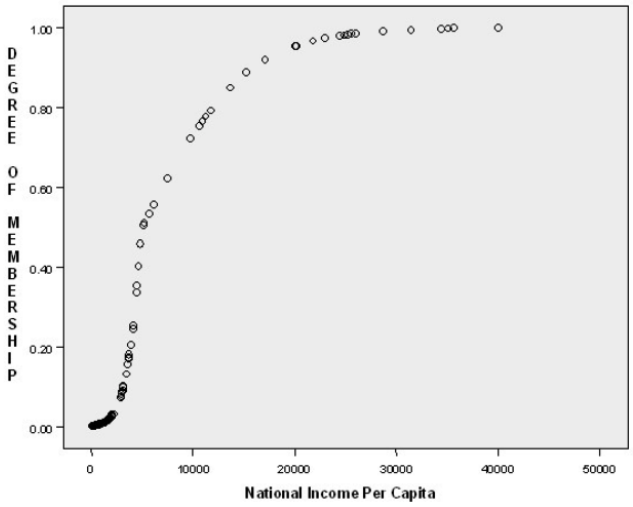
III. Fuzzy-set QCA

Country	Crisp set	Continuous fuzzy set
A	0	0.27
B	1	0.95
C	1	0.77
D	0	0.41
E	0	0.19
F	1	0.55

0 = non-membership
1 = full-membership

Partial membership in a condition allowed!

Plot of Degree of Membership in the Set of Rich Countries



I. What is QCA

- 1.1 Boolean algebra
- 1.2 Boolean minimisation
- 1.3 Necessary vs. sufficient conditions (I)
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II. Crisp-set QCA

- 2.1 The truth table
- 2.2 Types of configurations
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III. Fuzzy-set QCA

- 3.1 Calibration of fuzzy-set
- 3.2 Logical AND & OR
- 3.3 Necessary vs. sufficient conditions (II)

Examples of fuzzy-set calibration

Crisp set	3-value fuzzy set	4-value fuzzy set	6-value fuzzy set	Continuous fuzzy set
1 = fully in 0 = fully out	1 = fully in 0.5 = neither fully in nor fully out 0 = fully out	1 = fully in 0.67 = more in than out 0.33 = more out than in 0 = fully out	1 = fully in 0.9 = mostly but not fully in 0.6 = more or less in 0.4 = more or less out 0.1 = mostly but not fully out 0 = fully out	1 = fully in 0.5 < x < 1 = more in than out 0.5 = neither in nor out 0 < x < .05 = fully out

Equal intervals are not necessary

Value of 0.5 = max. ambiguity regarding whether a case is in or out a condition

Reference: Ragin (2008). Qualitative Comparative Analysis using Fuzzy Sets (fsQCA). In *Configurational Comparative Methods: Qualitative Comparative Analysis and Related Techniques.* SAGE Publication.

CASE	GNPCAP: 550	URBANIZA: 50	LITERACY: 75	INDLAB: 30	GOVSTAB: 10	SURVIVAL
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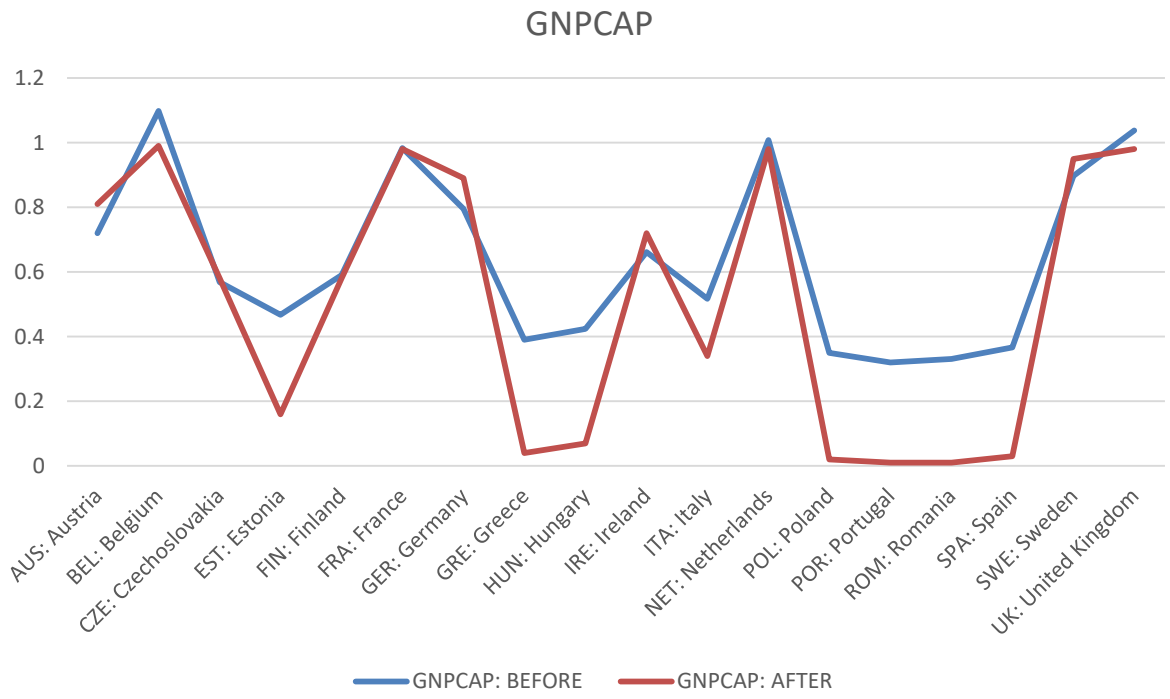
BEL: Belgium	1098	60.5	94.4	48.9	4	0.95
CZE: Czechoslovakia	568	69.0	95.9	37.4	6	0.89
EST: Estonia	468	28.5	95	14.0	6	0.12
FIN: Finland	590	22.0	99.1	22.0	9	0.77
FRA: France	983	21.2	96.2	34.8	5	0.95
GER: Germany	795	56.5	98.0	40.4	11	0.05
GRE: Greece	390	31.1	59.2	28.1	10	0.06
HUN: Hungary	424	36.3	85.0	21.6	13	0.42
IRE: Ireland	662	25.0	95.0	14.5	5	0.92
ITA: Italy	517	31.4	72.1	29.6	9	0.05
NET: Netherlands	1008	78.8	99.9	39.3	2	0.95
POL: Poland	350	37.0	76.9	11.2	21	0.12
POR: Portugal	320	15.3	38.0	23.1	19	0.05
ROM: Romania	331	21.9	61.8	12.2	7	0.21
SPA: Spain	367	43.0	55.6	25.2	12	0.06
SWE: Sweden	897	34.0	99.9	32.3	6	0.95
UK: United Kingdom	1038	74.0	99.9	49.9	4	0.95

Reference: Ragin (2008). Qualitative Comparative Analysis using Fuzzy Sets (fsQCA). In *Configurational Comparative Methods: Qualitative Comparative Analysis and Related Techniques.* SAGE Publication.

CASE	GNPCAP: 550	URBANIZA: 50	LITERACY: 75	INDLAB: 30	GOVSTAB: 10	SURVIVAL
AUS: Austria	0.81	0.12	0.99	0.73	0.43	0.05
BEL: Belgium	0.99	0.89	0.98	1.00	0.98	0.95
CZE: Czechoslovakia	0.58	0.98	0.98	0.90	0.91	0.89
EST: Estonia	0.16	0.07	0.98	0.01	0.91	0.12
FIN: Finland	0.58	0.03	0.99	0.08	0.58	0.77
FRA: France	0.98	0.03	0.99	0.81	0.95	0.95
GER: Germany	0.89	0.79	0.99	0.96	0.31	0.05
GRE: Greece	0.04	0.09	0.13	0.36	0.43	0.06
HUN: Hungary	0.07	0.16	0.88	0.07	0.13	0.42
IRE: Ireland	0.72	0.05	0.98	0.01	0.95	0.92
ITA: Italy	0.34	0.10	0.41	0.47	0.58	0.05
NET: Netherlands	0.98	1.00	0.99	0.94	0.99	0.95
POL: Poland	0.02	0.17	0.59	0.00	0.00	0.12
POR: Portugal	0.01	0.02	0.01	0.11	0.01	0.05
ROM: Romania	0.01	0.03	0.17	0.00	0.84	0.21
SPA: Spain	0.03	0.30	0.09	0.21	0.20	0.06
SWE: Sweden	0.95	0.13	0.99	0.67	0.91	0.95
UK: United Kingdom	0.98	0.99	0.99	1.00	0.98	0.95

Reference: Ragin (2008). Qualitative Comparative Analysis using Fuzzy Sets (fsQCA). In *Configurational Comparative Methods: Qualitative Comparative Analysis and Related Techniques.* SAGE Publication.

Calibration: before vs. after



Redesigning Social Inquiry

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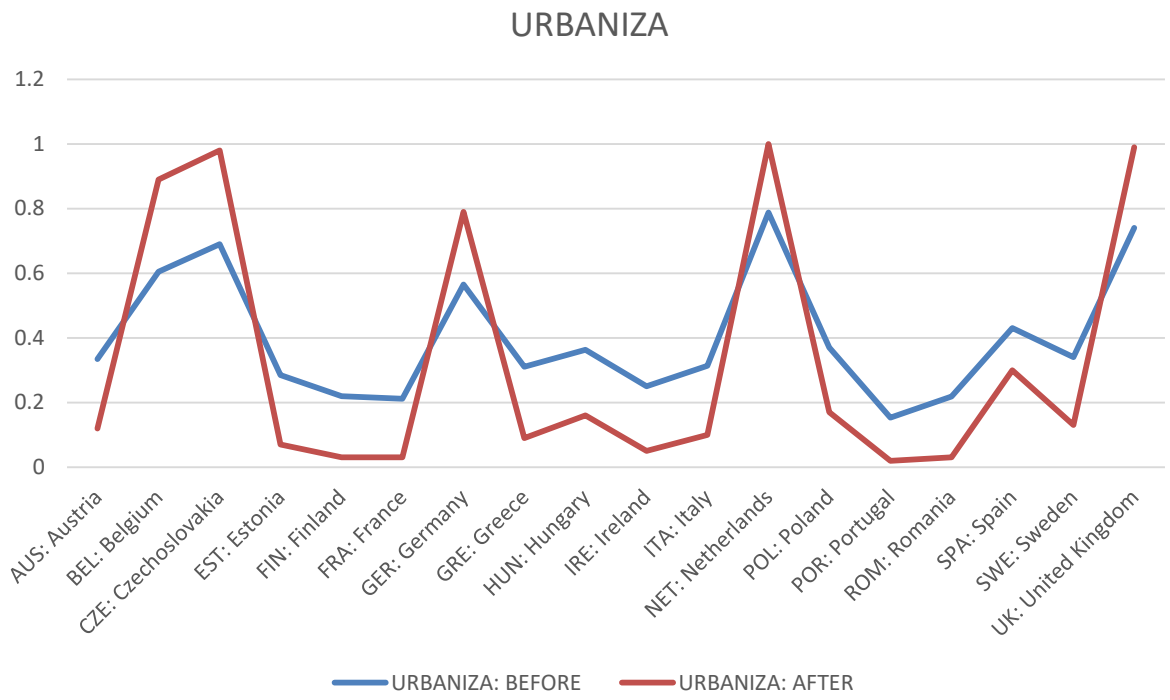
Calibration: before vs. after



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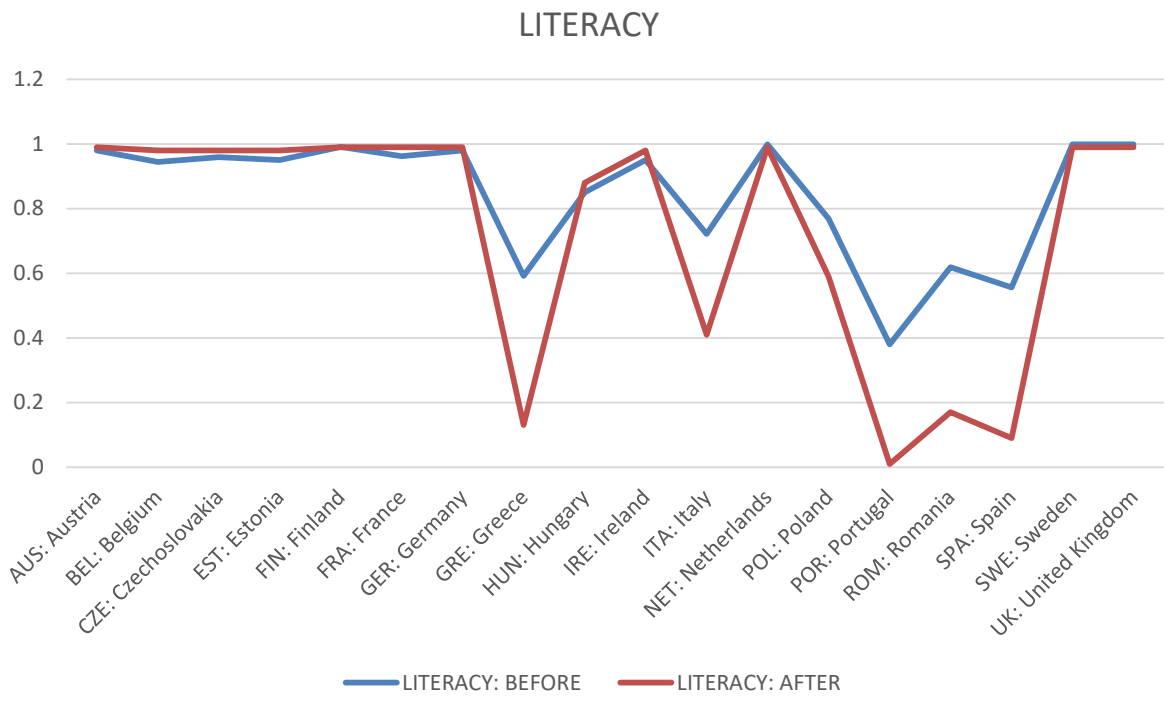
Calibration: before vs. after



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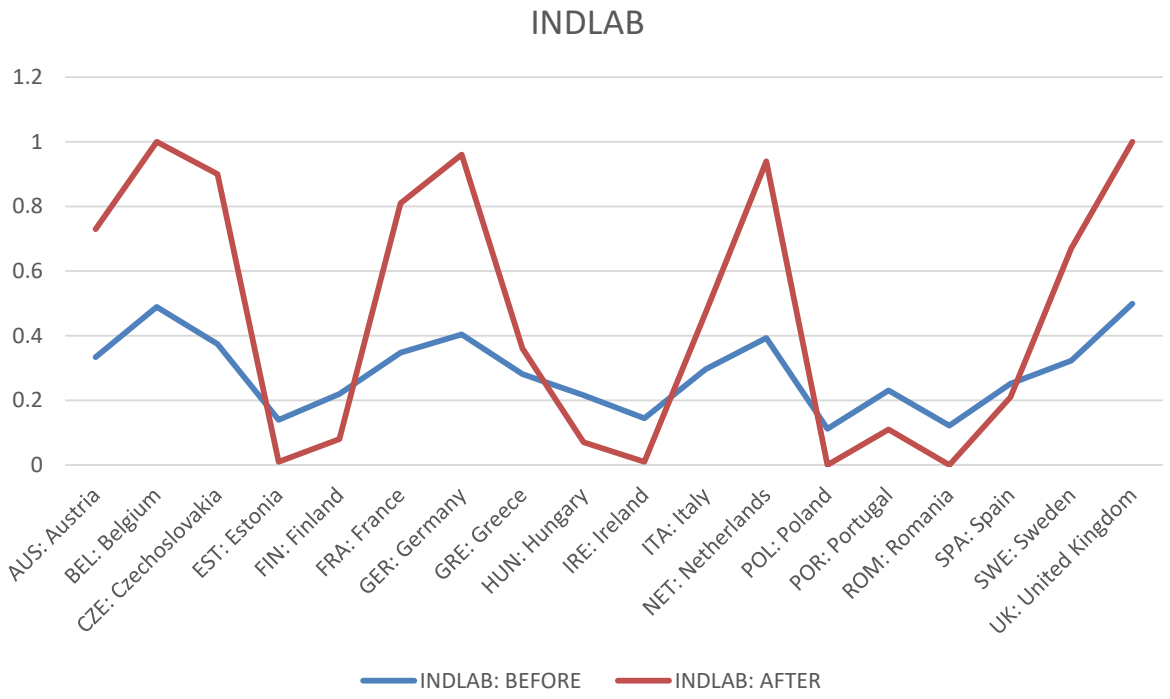
Calibration: before vs. after

Redesigning Social Inquiry



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www.u.arizona.edu/~cragin
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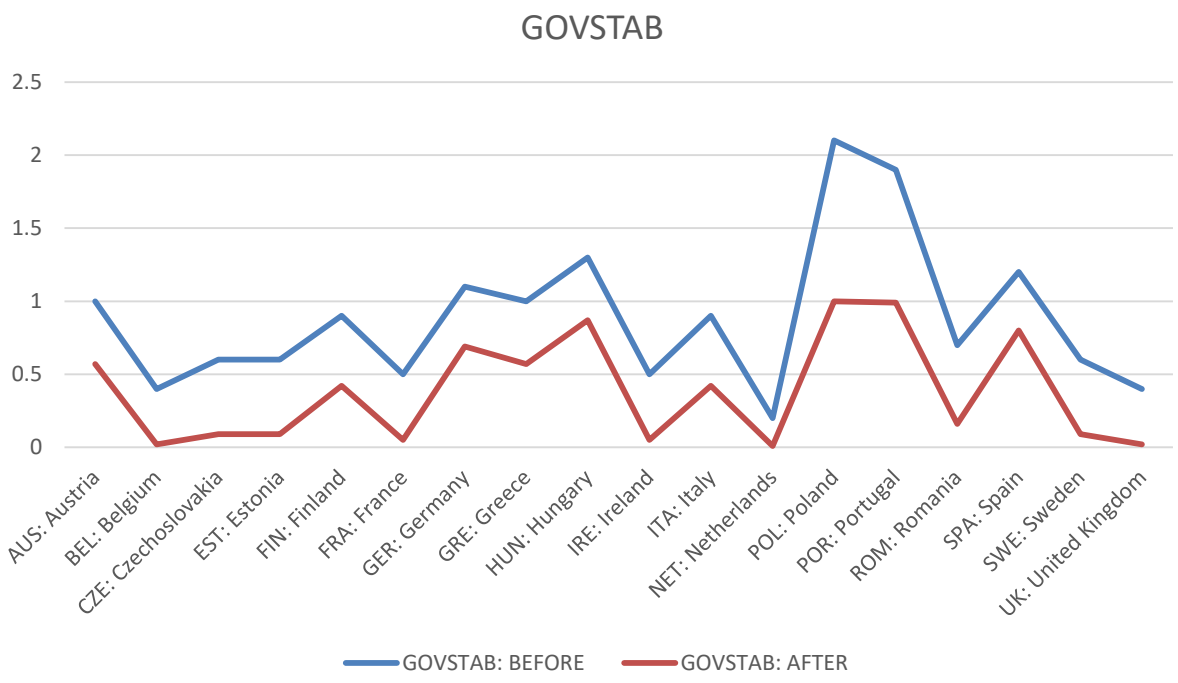
Calibration: before vs. after



Redesigning Social Inquiry

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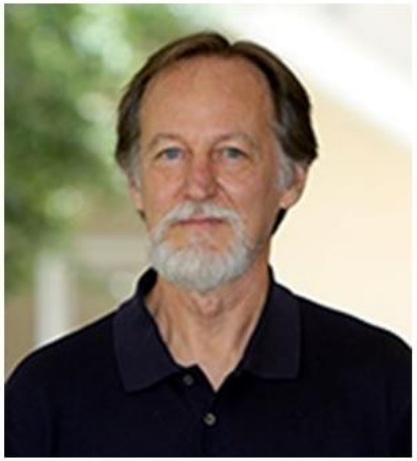
3.1 Calibration of fuzzy-set

"The specific translation of ordinal ranks to fuzzy membership scores depends on the ***fit*** between the content of the ordinal categories and the researcher's conceptualisation of the fuzzy set…researchers must calibrate membership scores using ***substantive and theoretical knowledge and should NOT be mechanical***" (Rihoux & de Meur, 2012, p.92)



Reference: Ragin (2008). Qualitative Comparative Analysis using Fuzzy Sets (fsQCA). In *Configurational Comparative Methods: Qualitative Comparative Analysis and Related Techniques.* SAGE Publication.

I. What is QCA

- 1.1 Boolean algebra
- 1.2 Boolean minimisation
- 1.3 Necessary vs. sufficient conditions (I)
- 1.4 Veen diagram

II. Crisp-set QCA

- 2.1 The truth table
- 2.2 Types of configurations
- 2.3 Resolve contradictory configurations

III. Fuzzy-set QCA

- 3.1 Calibration of fuzzy-set
- 3.2 Logical AND & OR
- 3.3 Necessary vs. sufficient conditions (II)

3.2 Logical AND & OR

no longer as simple as

* = logical AND
\+ = logical OR

With fuzzy sets, ***logical AND*** is accomplished by taking the ***minimum*** membership score of each case in the sets of conditions that are combined.

With fuzzy sets, ***logical OR*** is accomplished by taking the ***maximum*** membership score of each case in the sets of conditions that are combined.

CASE	DEVELOPMENT (D)	URBANISATION (U)	LITERACY (L)	logical AND (min)	Logical OR (max)
AUS: Austria	0.81	0.12	0.99	?	?
BEL: Belgium	0.99	0.89	0.98	?	?
CZE: Czechoslovakia	0.58	0.98	0.98	?	?
EST: Estonia	0.16	0.07	0.98	?	?
FIN: Finland	0.58	0.03	0.99	?	?
FRA: France	0.98	0.03	0.99	?	?
GER: Germany	0.89	0.79	0.99	?	?
GRE: Greece	0.04	0.09	0.13	?	?
HUN: Hungary	0.07	0.16	0.88	?	?
IRE: Ireland	0.72	0.05	0.98	?	?
ITA: Italy	0.34	0.10	0.41	?	?
NET: Netherlands	0.98	1.00	0.99	?	?
POL: Poland	0.02	0.17	0.59	?	?
POR: Portugal	0.01	0.02	0.01	?	?
ROM: Romania	0.01	0.03	0.17	?	?
SPA: Spain	0.03	0.30	0.09	?	?
SWE: Sweden	0.95	0.13	0.99	?	?
UK: United Kingdom	0.98	0.99	0.99	?	?

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CASE	DEVELOPMENT (D)	URBANISATION (U)	LITERACY (L)	logical AND (min) D * U * L	Logical OR (max) D + U + L
AUS: Austria	0.81	0.12	0.99	0.12	0.99
BEL: Belgium	0.99	0.89	0.98	0.89	0.98
CZE: Czechoslovakia	0.58	0.98	0.98	0.58	0.98
EST: Estonia	0.16	0.07	0.98	0.07	0.98
FIN: Finland	0.58	0.03	0.99	0.03	0.99
FRA: France	0.98	0.03	0.99	0.03	0.99
GER: Germany	0.89	0.79	0.99	0.79	0.99
GRE: Greece	0.04	0.09	0.13	0.04	0.13
HUN: Hungary	0.07	0.16	0.88	0.07	0.88
IRE: Ireland	0.72	0.05	0.98	0.05	0.98
ITA: Italy	0.34	0.10	0.41	0.10	0.41
NET: Netherlands	0.98	1.00	0.99	0.98	0.99
POL: Poland	0.02	0.17	0.59	0.02	0.59
POR: Portugal	0.01	0.02	0.01	0.01	0.02
ROM: Romania	0.01	0.03	0.17	0.01	0.17
SPA: Spain	0.03	0.30	0.09	0.03	0.30
SWE: Sweden	0.95	0.13	0.99	0.13	0.99
UK: United Kingdom	0.98	0.99	0.99	0.98	0.99

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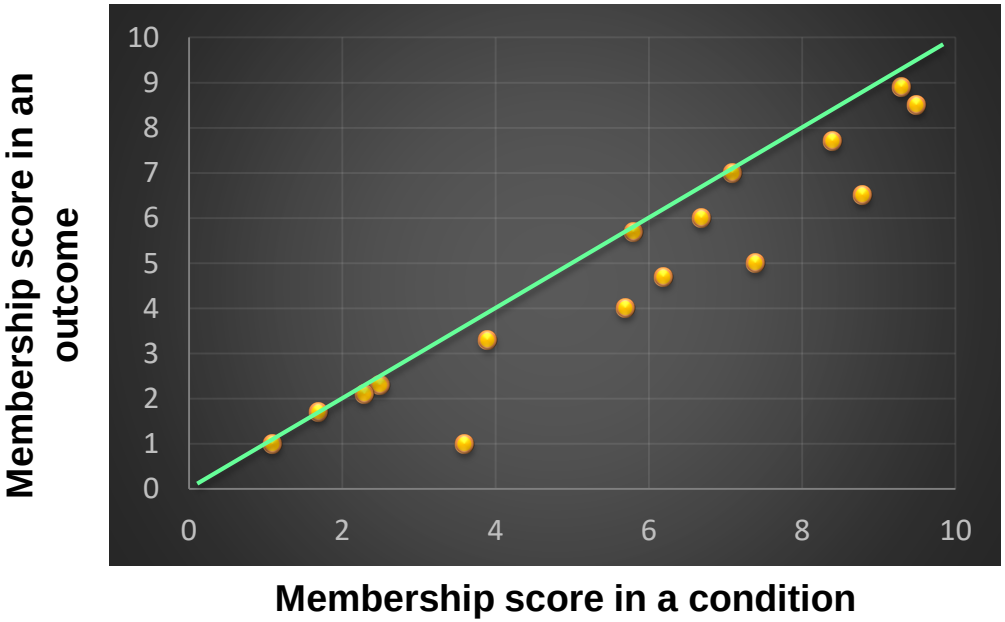
3.2 Necessary vs. sufficient conditions (II)

$$\text{Consistency } (Yi \leq Xi) = \sum(\min(Xi, Yi))/\sum(Yi)$$

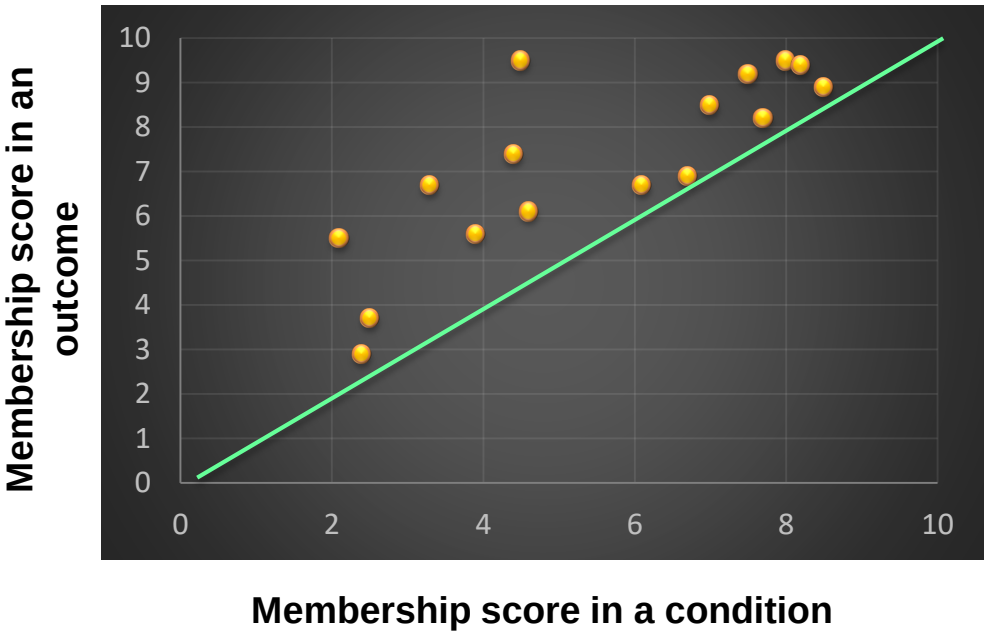


A ***necessary condition*** is a condition that must be present for the outcome to occur, but its presence does not guarantee that occurrence.

The set of cases within the outcome is a subset of cases within the causal conditions.

3.2 Necessary vs. sufficient conditions (II)

$$\text{Consistency } (Xi \leq Yi) = \sum(\min(Xi, Yi))/\sum(Xi)$$

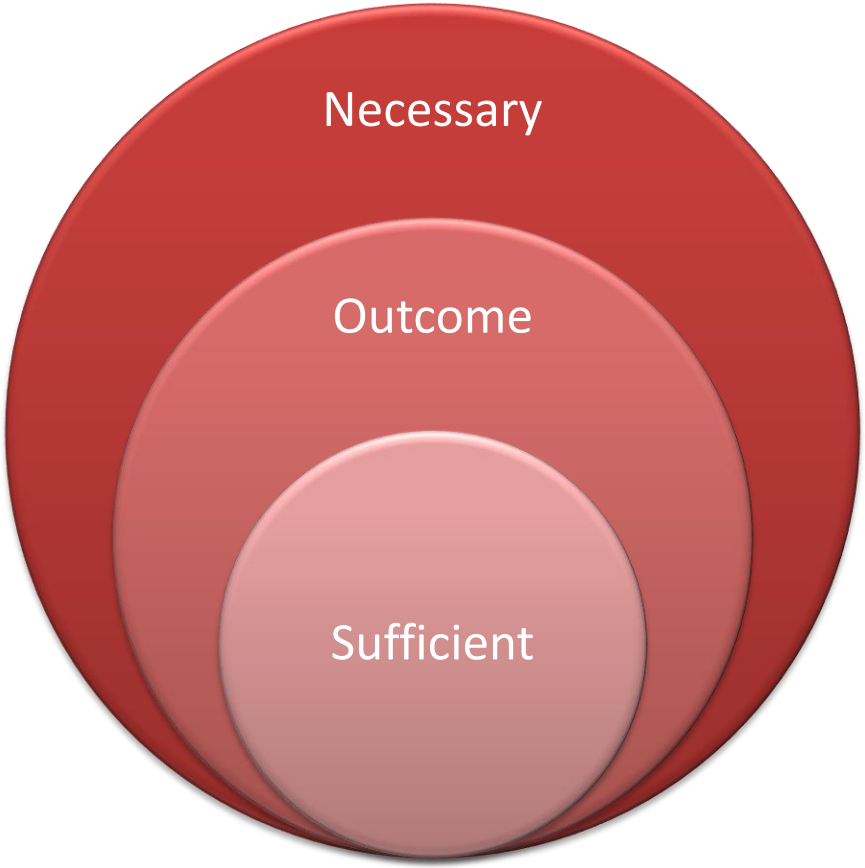


A ***sufficient condition*** is a condition that is sufficient for an outcome, if the outcome always occurs when the condition (or combination of conditions) is present.

The set of cases in a condition is also a subset of cases in the outcome.

Cooper, B., & Glaesser, J. (2016). Qualitative Comparative Analysis, Necessary Conditions, and Limited Diversity: Some Problematic Consequences of Schneider and Wagemann's Enhanced Standard Analysis. *Field Methods*, *28*(3), 300–315. https://doi.org/10.1177/1525822X15598974

3.2 Necessary vs. sufficient conditions (II)



CASE	DEVELOPMENT (D)	URBANISATION (U)	LITERATE (L)	logical AND (min) D * U * L	Logical OR (max) D + U + L
AUS: Austria	0.81	0.12	0.99	0.12	0.99
BEL: Belgium	0.99	0.89	0.98	0.89	0.98
CZE: Czechoslovakia	0.58	0.98	0.98	0.58	0.98
EST: Estonia	0.16	0.07	0.98	0.07	0.98
FIN: Finland	0.58	0.03	0.99	0.03	0.99
FRA: France	0.98	0.03	0.99	0.03	0.99
GER: Germany	0.89	0.79	0.99	0.79	0.99
GRE: Greece	0.04	0.09	0.13	0.04	0.13
HUN: Hungary	0.07	0.16	0.88	0.07	0.88
IRE: Ireland	0.72	0.05	0.98	0.05	0.98
ITA: Italy	0.34	0.10	0.41	0.10	0.41
NET: Netherlands	0.98	1.00	0.99	0.98	0.99
POL: Poland	0.02	0.17	0.59	0.02	0.59
POR: Portugal	0.01	0.02	0.01	0.01	0.02
ROM: Romania	0.01	0.03	0.17	0.01	0.17
SPA: Spain	0.03	0.30	0.09	0.03	0.30
SWE: Sweden	0.95	0.13	0.99	0.13	0.99
UK: United Kingdom	0.98	0.99	0.99	0.98	0.99

Reference: Ragin (2008). Qualitative Comparative Analysis using Fuzzy Sets (fsQCA). In *Configurational Comparative Methods: Qualitative Comparative Analysis and Related Techniques.* SAGE Publication.

CASE	D	U	L	D * U * L	~ D	~ U	~ L	~ D * ~ U * ~ L	Survival	Breakdown
AUS: Austria	0.81	0.12	0.99	0.12	0.19	0.88	0.01	0.01	0.05	0.95
BEL: Belgium	0.99	0.89	0.98	0.89	0.01	0.11	0.02	0.01	0.95	0.05
CZE: Czechoslovakia	0.58	0.98	0.98	0.58	0.42	0.02	0.02	0.02	0.89	0.11
EST: Estonia	0.16	0.07	0.98	0.07	0.84	0.93	0.02	0.02	0.12	0.88
FIN: Finland	0.58	0.03	0.99	0.03	0.42	0.97	0.01	0.01	0.77	0.23
FRA: France	0.98	0.03	0.99	0.03	0.02	0.97	0.01	0.01	0.95	0.05
GER: Germany	0.89	0.79	0.99	0.79	0.11	0.21	0.01	0.01	0.05	0.95
GRE: Greece	0.04	0.09	0.13	0.04	0.96	0.91	0.87	0.87	0.06	0.94
HUN: Hungary	0.07	0.16	0.88	0.07	0.93	0.84	0.12	0.12	0.42	0.58
IRE: Ireland	0.72	0.05	0.98	0.05	0.28	0.95	0.02	0.02	0.92	0.08
ITA: Italy	0.34	0.10	0.41	0.10	0.66	0.90	0.59	0.59	0.05	0.95
NET: Netherlands	0.98	1.00	0.99	0.98	0.02	0.00	0.01	0.00	0.95	0.05
POL: Poland	0.02	0.17	0.59	0.02	0.98	0.83	0.41	0.41	0.12	0.88
POR: Portugal	0.01	0.02	0.01	0.01	0.99	0.98	0.99	0.98	0.05	0.95
ROM: Romania	0.01	0.03	0.17	0.01	0.99	0.97	0.83	0.83	0.21	0.79
SPA: Spain	0.03	0.30	0.09	0.03	0.97	0.70	0.91	0.70	0.06	0.94
SWE: Sweden	0.95	0.13	0.99	0.13	0.05	0.87	0.01	0.01	0.95	0.05
UK: United Kingdom	0.98	0.99	0.99	0.98	0.02	0.01	0.01	0.01	0.95	0.05

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CASE	D	U	L	D * U * L	~ D	~ U	~ L	~ D * ~ U * ~ L	Survival	Breakdown
AUS: Austria	0.81	0.12	0.99	0.12	0.19	0.88	0.01	0.01	0.05	0.95
BEL: Belgium	0.99	0.89	0.98	0.89	0.01	0.11	0.02	0.01	0.95	0.05
CZE: Czechoslovakia	0.58	0.98	0.98	0.58	0.42	0.02	0.02	0.02	0.89	0.11
EST: Estonia	0.16	0.07	0.98	0.07	0.84	0.93	0.02	0.02	0.12	0.88
FIN: Finland	0.58	0.03	0.99	0.03	0.42	0.97	0.01	0.01	0.77	0.23
FRA: France	0.98	0.03	0.99	0.03	0.02	0.97	0.01	0.01	0.95	0.05
GER: Germany	0.89	0.79	0.99	0.79	0.11	0.21	0.01	0.01	0.05	0.95
GRE: Greece	0.04	0.09	0.13	0.04	0.96	0.91	0.87	0.87	0.06	0.94
HUN: Hungary	0.07	0.16	0.88	0.07	0.93	0.84	0.12	0.12	0.42	0.58
IRE: Ireland	0.72	0.05	0.98	0.05	0.28	0.95	0.02	0.02	0.92	0.08
ITA: Italy	0.34	0.10	0.41	0.10	0.66	0.90	0.59	0.59	0.05	0.95
NET: Netherlands	0.98	1.00	0.99	0.98	0.02	0.00	0.01	0.00	0.95	0.05
POL: Poland	0.02	0.17	0.59	0.02	0.98	0.83	0.41	0.41	0.12	0.88
POR: Portugal	0.01	0.02	0.01	0.01	0.99	0.98	0.99	0.98	0.05	0.95
ROM: Romania	0.01	0.03	0.17	0.01	0.99	0.97	0.83	0.83	0.21	0.79
SPA: Spain	0.03	0.30	0.09	0.03	0.97	0.70	0.91	0.70	0.06	0.94
SWE: Sweden	0.95	0.13	0.99	0.13	0.05	0.87	0.01	0.01	0.95	0.05
UK: United Kingdom	0.98	0.99	0.99	0.98	0.02	0.01	0.01	0.01	0.95	0.05

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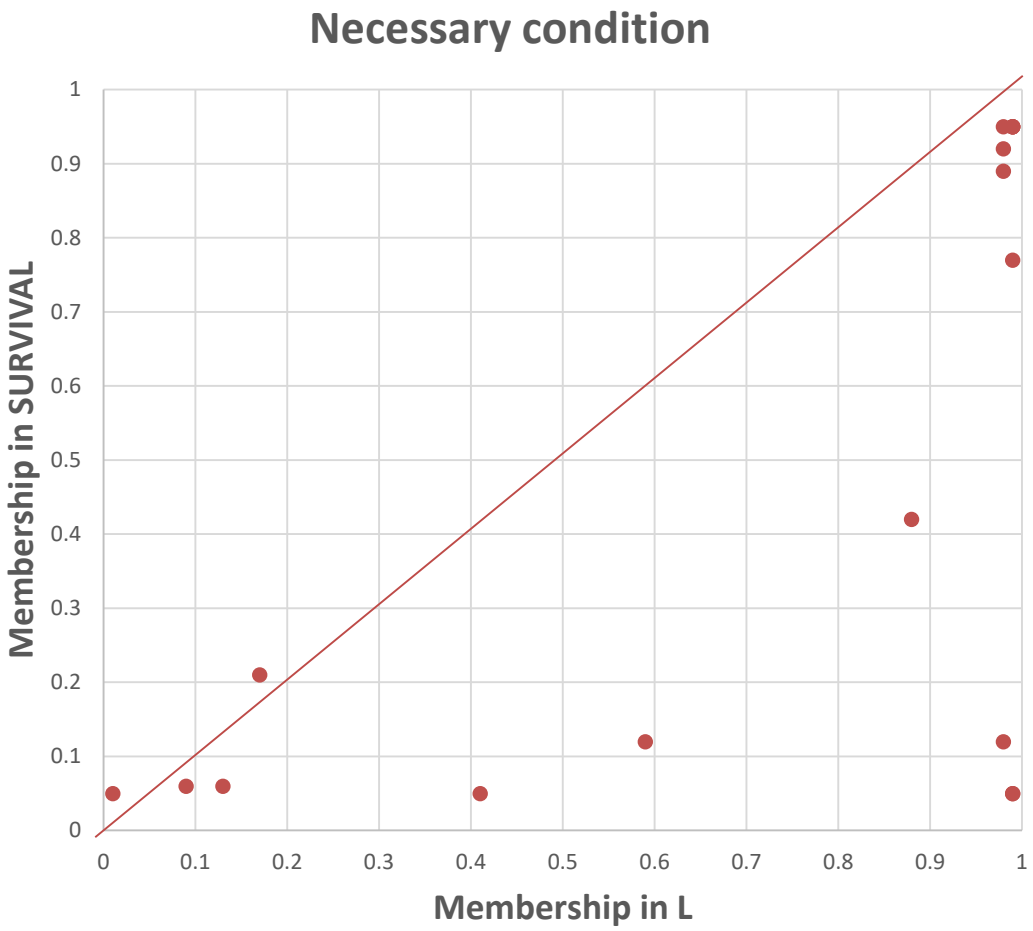

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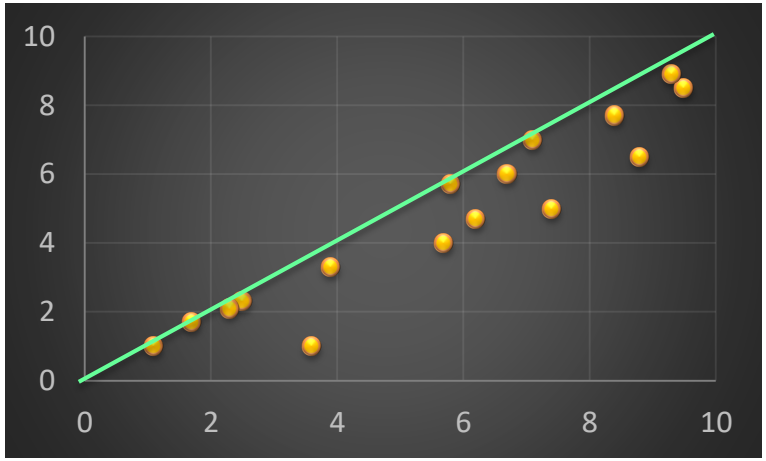

CASE	D	U	L	D * U * L	~ D	~ U	~ L	~ D * ~ U * ~ L	Survival	Breakdown
AUS: Austria	0.81	0.12	0.99	0.12	0.19	0.88	0.01	0.01	0.05	0.95
BEL: Belgium	0.99	0.89	0.98	0.89	0.01	0.11	0.02	0.01	0.95	0.05
CZE: Czechoslovakia	0.58	0.98	0.98	0.58	0.42	0.02	0.02	0.02	0.89	0.11
EST: Estonia	0.16	0.07	0.98	0.07	0.84	0.93	0.02	0.02	0.12	0.88
FIN: Finland	0.58	0.03	0.99	0.03	0.42	0.97	0.01	0.01	0.77	0.23
FRA: France	0.98	0.03	0.99	0.03	0.02	0.97	0.01	0.01	0.95	0.05
GER: Germany	0.89	0.79	0.99	0.79	0.11	0.21	0.01	0.01	0.05	0.95
GRE: Greece	0.04	0.09	0.13	0.04	0.96	0.91	0.87	0.87	0.06	0.94
HUN: Hungary	0.07	0.16	0.88	0.07	0.93	0.84	0.12	0.12	0.42	0.58
IRE: Ireland	0.72	0.05	0.98	0.05	0.28	0.95	0.02	0.02	0.92	0.08
ITA: Italy	0.34	0.10	0.41	0.10	0.66	0.90	0.59	0.59	0.05	0.95
NET: Netherlands	0.98	1.00	0.99	0.98	0.02	0.00	0.01	0.00	0.95	0.05
POL: Poland	0.02	0.17	0.59	0.02	0.98	0.83	0.41	0.41	0.12	0.88
POR: Portugal	0.01	0.02	0.01	0.01	0.99	0.98	0.99	0.98	0.05	0.95
ROM: Romania	0.01	0.03	0.17	0.01	0.99	0.97	0.83	0.83	0.21	0.79
SPA: Spain	0.03	0.30	0.09	0.03	0.97	0.70	0.91	0.70	0.06	0.94
SWE: Sweden	0.95	0.13	0.99	0.13	0.05	0.87	0.01	0.01	0.95	0.05
UK: United Kingdom	0.98	0.99	0.99	0.98	0.02	0.01	0.01	0.01	0.95	0.05

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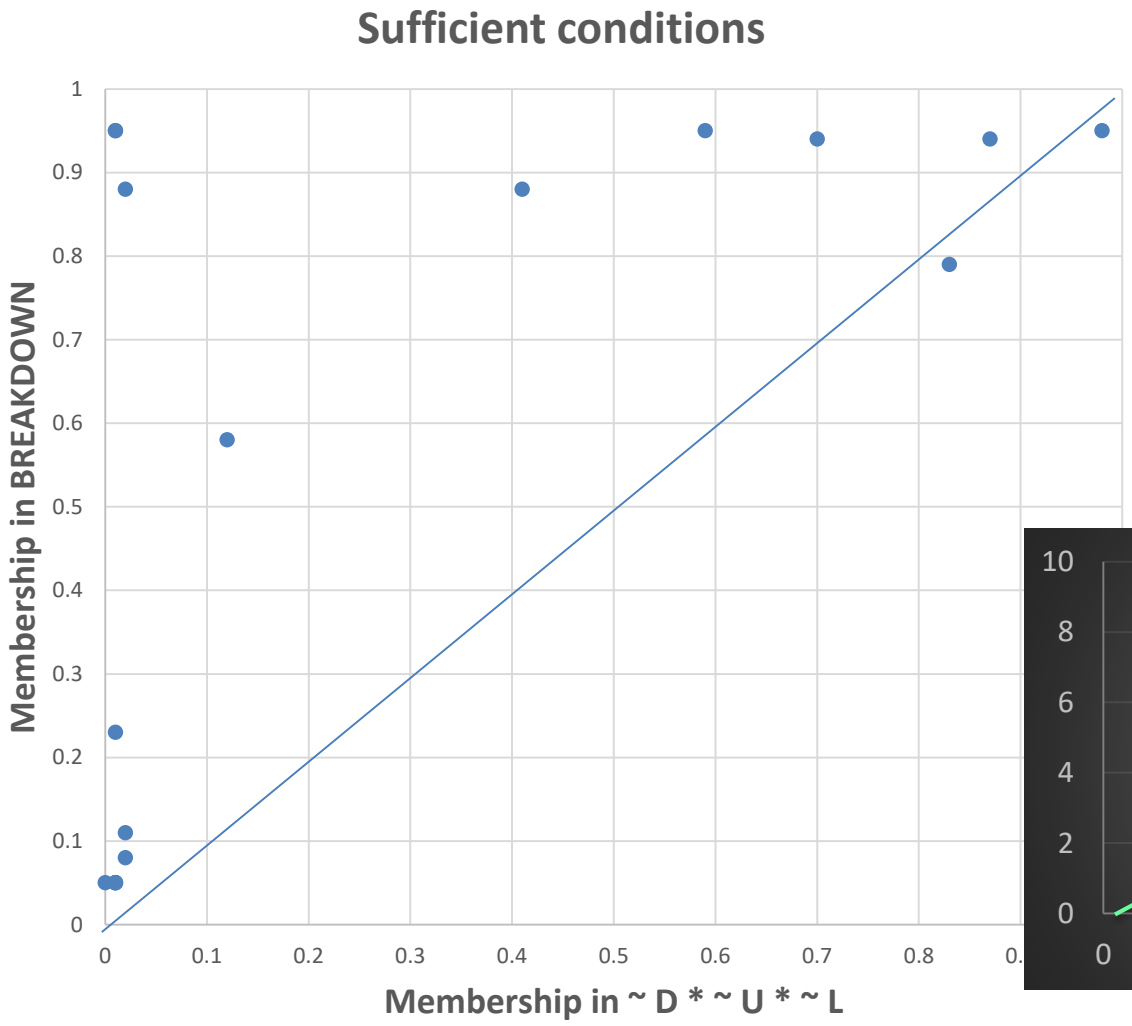

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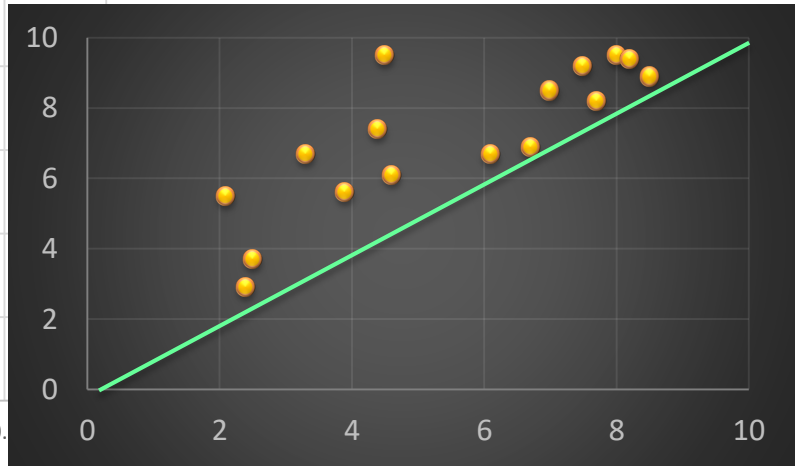

Software packages

http://www.socsci.uci.edu/~cragin/fsQCA/software.shtml

https://www.tosmana.net/

https://www.r-project.org/

Further reading

Cooper, B., & Glaesser, J. (2016). Qualitative Comparative Analysis, Necessary Conditions, and Limited Diversity: Some Problematic Consequences of Schneider and Wagemann's Enhanced Standard Analysis. Field Methods, 28(3), 300–315. https://doi.org/10.1177/1525822X15598974

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Any questions?

Thank you!