IV. The Concept and Method of fsQCA

IV-1. Content of This Chapter

This chapter explains the method of fsQCA (fuzzy set Qualitative Comparative Analysis). While fsQCA can be seen as an extension of csQCA (crisp set QCA) to continuous numerical data rather than binary data, it might be more accurate to consider csQCA as a special case of fsQCA. In any case, the data will be organized using Excel's sorting function, as was done with csQCA. The two challenging aspects of fsQCA are the membership function and the evaluation of consistency. The books I have read provided some explanation on the evaluation of consistency but only described the membership function as a degree of belonging to a set, without explaining the difference between "probability" and "degree" of belonging or what kind of function the membership function is. However, since fsQCA follows the flow of csQCA, there is a caution to carefully set the position of the degree of belonging (0.50), and it is recommended to use software for this purpose. Beyond that, there is no further explanation of the membership function. It is not a manual for the method. Therefore, the commentator will explain it with some imagination.

The difference between "probability" and "degree" is that probability assumes an even distribution within the whole, while degree assumes an uneven distribution, meaning the degree of belonging to something varies among groups. Therefore, probability can be multiplied, but degree cannot. In practical terms, since probability is a value less than or equal to 1, the probability of belonging to an intersection of several conditions naturally becomes quite small. When this is directly compared to the "probability" of an outcome occurring, the probability of belonging to the logical intersection of repeatedly multiplied conditions is usually smaller than the probability of the outcome occurring. If it is a combination of single sets (not the logical intersection of several conditions, but a set distinguished by only one condition), and if the degree of fit of members belonging to that set is always smaller than the degree of fit to the other set, it can probably be judged that the set belongs to the set where the outcome occurred (since it never deviates from the outcome set, it is a subset of the other set). Since probability assumes an even distribution, such a judgment cannot be made.

Another issue that troubles analysts is the concept of "neither" or "ordinary." I view the world with myself as the standard (origin), with those smarter, wealthier, and better-looking than me distributed above, and those less intelligent, poorer, and less attractive distributed below. In other words, I consider myself as ordinary. The general perspective is that there exists a vague notion of ordinary, with distributions above and below it. The position of probability 0.5 is arbitrarily set. First, there is the question of whether this distribution is symmetrical. Some argue that such a distribution makes probability distributions meaningless. While this is true, non-normal distributions are common in everyday life and often trouble analysts. They sometimes forcefully transform and approximate to a normal distribution. When it comes to degree of fit, there is the idea that analysts can set 0.5 based on their judgment, leading to the concept of the membership function (degree of fit). Although it is called a membership function, there is no such function. There are only membership values representing the degree of fit and methods of expressing data. However, software includes such functions (functions) that calculate the degree of fit when given conditions. Fuzzy theory and fuzzy operations perform operations like the logical product and logical sum of degrees of fit. In fuzzy operations, the membership value of an intersection is the minimum membership value of the original sets. Therefore, the number of original sets does not matter. This kind of thinking forms the basis of fsQCA. With an understanding of these basic concepts, we move on to specific explanations. First, we will explain the membership function and the calculation of consistency (IV-2-1, IV-2-2). Then, using data from interwar Europe, we will conduct fsQCA to understand the implementation procedures and logical structure of fsQCA (IV-3).

IV-2-1. Fuzzy Operation and Membership Function

In the initial explanation of fsQAC, it is mentioned that fsQAC is an application of Fuzzy theory. It is explained that because it is a Fuzzy operation, the membership value of the logical product of combined conditions is the minimum value of the original combined conditions. Saying "because it is a Fuzzy operation" is not an explanation; it is an excuse for doing something unclear.

In Fuzzy operations, the membership value of the logical product $A \wedge B$ belonging to both condition A and condition B simultaneously is:

$$\mu(A \wedge B) = min\{\mu(A), \mu(B)\}$$

$$\mu(A \wedge B \wedge C \wedge \cdots) = min\{\mu(A), \mu(B), \mu(C) \cdots\}$$

The membership value of the logical sum belonging to at least one of the conditions is:

$$\mu(A \vee B) = max\{\mu(A), \mu(B)\}$$

$$\mu(A \vee B \vee C \vee \cdots) = max\{\mu(A), \mu(B), \mu(C) \cdots\}$$

In other words, the membership value of the logical product of two conditions is the smaller of the membership values of the original conditions. The membership function of the logical product of three or more conditions is the smallest membership value of the original conditions. The membership value of the logical sum of two conditions is the larger of the membership values of the original data, and the membership value of the logical sum of three or more conditions is the largest membership value of the original conditions.

It may seem a bit strange, but this way of thinking is common in everyday life. For example, it is not uncommon for people to decide on a travel destination by considering it as shown in Table 11. In most cases, people do not have much information about travel destinations, and some items of information are missing. This is the point: in such cases, people compare the items with the lowest values among various evaluation items. For example, Kyoto has the lowest value in the evaluation items, with a price of 0.30. Therefore, no matter how other items are evaluated, Kyoto's evaluation value is 0.30. On the other hand, Kawagoe has a high evaluation value for the price, even if the evaluations for scenery and entertainment are lower compared to others, with the lowest values being 0.60. Therefore, Kawagoe's evaluation value is 0.60, making it a

Table 11. Selection of destination of travel in summer holiday

	subjective evaluation of happiness						result
destination	SCE	TRD	CNV	FOD	AMS	PRC	TE
Kyoto	0.80	0.95	0.40	0.95	0.60	0.30	0.30
Nikko	0.95	0.90	0.30	0.90	0.50	0.40	0.30
Hakone	0.95	0.80	0.50	*	0.8	0.40	0.40
Atami	0.70	0.60	0.80	0.75	0.40	0.50	0.40
Kawagoe	0.60	*	0.95	0.80	0.60	0.95	0.60
Tateyama	0.90	0.20	0.40	0.90	*	0.95	0.20

SCE: scenery
TRD: Tradition
CNV: Convenience
FOD: food
AMS: amusement
PRC: Price
TE: Total evaluation
*: No information

higher evaluation compared to other travel destinations and thus selected as a travel destination.

A common explanation of Fuzzy theory involves the speed control of a car. The safety of a moving car is a complex system influenced by factors such as speed, curve radius, vehicle weight, driver skill, road resistance, wind, and more. By keeping other conditions constant, we can express the relationship between speed and safety with some function. Similarly, the relationship between curve radius and safety can also be expressed with some function. The problem is how to evaluate and control the safety of a car traveling at a certain speed and curvature. This involves the safety of the combined conditions, which is a matter of logical conjunction. It is immediately clear that the safety cannot be simply multiplied. If the safety under one condition is $p(A)$ and the safety under another condition is $p(B)$, it is obviously wrong to consider the safety of the combined condition $A \wedge B$ as $p(A)p(B)$. Both $p(A)$ and $p(B)$ are values less than 1. Multiplying them, $p(A)p(B)$, results in a value smaller than either $p(A)$ or $p(B)$. Even when this value falls below a certain threshold, the individual values of $p(A)$ and $p(B)$p(A) may still exceed the threshold. Control is necessary when either $p(A)$ or $p(B)$ falls below the threshold. In other words, the safety of the combined condition is the lower value of the original combined conditions.

Table 12 shows the truth table of the operations we performed using fsQCA, indicating the logical AND and OR in the result column. The logical AND becomes 1 only when both A and B are 1, otherwise, it is 0. The logical OR becomes 0 only when both A and B are 0, otherwise, it is 1. In Fuzzy operations, the logical AND selects the smaller membership value, while the logical OR selects the larger membership value. Table 13 shows the results of these operations. Next, we performed fuzzy operations with the binary membership values of A and B set to μ(A)=1 and μ(B)=1 (Table 14). The results are the same as those of binary operations. In other words, binary logical operations are a special case of fuzzy operations. Fuzzy theory consistently incorporates the logical

Table12 Two value logic operation

	A	B	$A \wedge B$	$A \vee B$
A-B	1	1	1	1
A-b	1	0	0	1
a-B	0	1	0	1
a-b	0	0	0	0

Table 13. Fuzzy operation ($\mu(A) = 0.8, \mu(B) = 0.7$)

	A	B	$A \wedge B$	$A \vee B$
A-B	0.8	0.7	0.7	0.8
A-b	0.8	0.3	0.3	0.8
a-B	0.2	0.7	0.2	0.7
a-b	0.2	0.3	0.2	0.3

Table 14. Fuzzy operation ($\mu(A) = 1, \mu(B) = 1$)

	A	B	$A \wedge B$	$A \vee B$
A-B	1	1	1	1
A-b	1	0	0	1
a-B	0	1	0	1
a-b	0	0	0	0

operations we consider as “logic,” and the overall logical structure is coherent.

Putting Fuzzy theory aside, the most important aspect in this section is how to determine the membership values and the content of the membership functions. The translation of the QCA guidebook I read does not include the content of the membership functions. It only states that one should determine the membership values based on various information in a convincing manner, and that the QCA software has functions to determine the membership values, which should be used. Indeed, the software likely has commands with such functions, which they refer to as membership functions. However, it is unreasonable to determine these values arbitrarily. Therefore, I estimated the method of determining the membership values based on the membership values actually used in the guidebook and the fragmentary information within it. The only clue in the guidebook is that the value at which the cumulative percentage reaches 50% is important. From these fragmentary pieces of information, I deduced the method for calculating the membership values.

Figure 23 shows the relationship between the richness data of A and the membership values used in the analysis without any explanation in the guidebook. The horizontal axis represents the original data, and the vertical axis represents the membership values. Overall, it resembles a cumulative probability curve. This curve is not point-symmetric like the cumulative probability curve of a normal distribution. A red mark is placed at the cumulative 0.5 point, and to the left of this point, the curve is steep, while

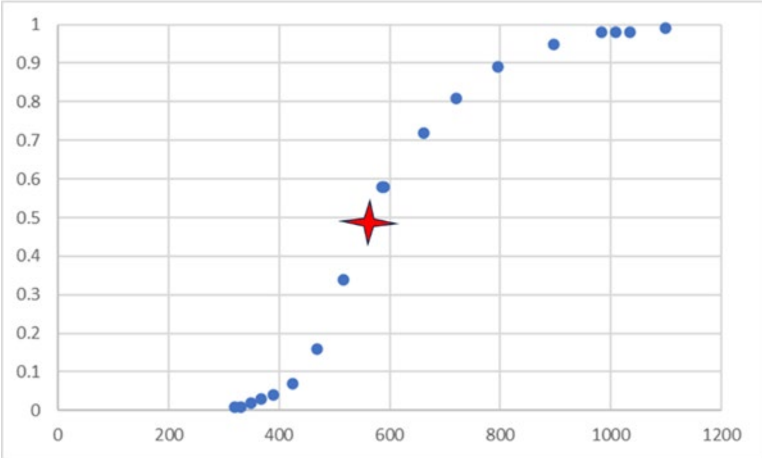

Fig.23. Scatter diagram of A(GNP/CAP)-membership score of A

Table 15. threshold at cumulative probability 0.05, 0.50 and 0.95(p)

p	0.05	0.50	0.95
A	400	550	900
B	25	50	65
C	50	75	90
D	20	30	40
E	15	9.5	5
R	-9	0	10

to the right, the curve is gentle. The left and right curves are relatively smooth, suggesting that some distribution curves are connected at the red point. Looking at the horizontal axis, this point is located around 550. For other data, the cumulative 0.5 points are at 50 for B's urbanization rate, 75 for C's literacy rate, 30 for D's industrial population rate, 9.5 for E's number of cabinets, and around 0 for democracy maintenance (R). These are the thresholds used in csQCA. In other words, two probability distribution curves are fitted at these points. This determines the center of the distribution, but next, we need to consider the spread to the left and right. This involves evaluating the degree of fit, i.e., how much cumulative probability is considered almost impossible or almost certain. In standard tests, significance is determined at a 5% risk level on one side, so the values of 0.05 and 0.95 are likely determined by the analyst's judgment. The guidebook also mentions that the software specifies the membership values of 0.05 and 0.95. From the plot of membership values against the data, the values corresponding to membership values of 0.05 and 0.95 can be identified. The results read from this are shown in Table 15. Finally, we need to consider the probability distribution curve to fit, but it can be anything. In extreme cases, even a straight line might be acceptable. However, if we inherit the binary logic underlying csQCA and define the function for calculating membership as the degree of fit, the probability curve to be fitted should be a logistic curve. The logistic curve is a probability curve known as the logistic distribution, which is the probability distribution of logit values. A logit value is the logarithm of the odds ratio. The odds ratio is the ratio of the probability of an event occurring to the probability of it not occurring. The probabilities of an event occurring and not occurring are complementary. Thus, the following equations apply:

$$\text{probability of an event occurring: } p$$

$$\text{probability of an event not occurring: } q$$

$$\text{complimentary relationship : } p \div q = 1$$

$$\text{odds ratio:} OR = \frac{p}{q} = \frac{p}{1-p}$$

$$\text{Logit value:logit}(P) = \log_e OR(p) = \log_e \frac{p}{1-p} = \log_e p - \log_e(1-p)$$

Rewriting this, we get:

$$\text{logit}(p) = \log_e \frac{p}{1-p}$$

$$e^{\text{logit}(p)} = \frac{p}{1-p}$$

$$e^{\text{logit}(p)}(1-p) = p$$

$$e^{\text{logit}(p)} - e^{\text{logit}(p)}p = p$$

$$e^{\text{logit}(p)} = p + e^{\text{logit}(p)}p = p\left(1 + e^{\text{logit}(p)}\right)$$

$$p = \frac{e^{\text{logit}(p)}}{1 + e^{\text{logit}(p)}}$$

In other words, given a logit value, the cumulative probability can be calculated. The logistic distribution is smoother and has wider tails than the normal distribution, but when adjusted for width, it becomes almost equivalent to the normal distribution with only slight skewness differences. Using these equations:

The logit value for $p = 0.95$ is

$$\text{logit}(0.95) = \log_e \frac{0.95}{1-0.95} = \log_e \frac{0.95}{0.05} = \log_e 19 = 2.944439$$

The logit value for $p = 0.50$ is

The logit value for $p = 0.05$ is

$$\text{logit}(0.95) = \log_e \frac{0.05}{1-0.05} = \log_e \frac{0.05}{0.95} = \log_e \frac{1}{19} = \log_e 1 - \log_e 19 = -2.944439$$

For example, in the case of richness, for values above 550, the membership value of 0.50 is at 550, and the membership value of 0.95 is at 900. The difference is 900 - 550. Given that the difference between the provided data and the origin is $v - 550$, the logit probability 0.50 logit value 0 to the probability 0.95 logit value difference of 2.944439 can be proportionally distributed. Therefore, the logit values for the data can be calculated as follows. The calculation process is left in Excel.logt.

$$logit(v) = 2.944439 \times \frac{v - 550}{900 - 550}$$

$$p(v) = \frac{e^{logot(v)}}{1 + e^{logit(v)}}$$

Table 16 compares the probability values (p) calculated using the logit transformation with the membership values (μ) used in the guidebook. Overall, they are almost identical, with some differences of about 0.01. The differences are highlighted in yellow. This discrepancy might be due to the rounding of numbers. Out of the 108 comparisons (18×6), there were 22 differences, which is about 20% of the total. This might be slightly too many to be attributed solely to rounding differences. Another possibility is that a probability distribution other than the logistic distribution was used. Unless

Table 16. Comparison of value calculated by logit transformation and membership value in text book

A		B		C		D		E		R	
p	μ	p	μ	p	μ	p	μ	p	μ	p	μ
0.81	0.81	0.12	0.12	0.99	0.99	0.73	0.73	0.43	0.43	0.05	0.05
0.99	0.99	0.89	0.89	0.98	0.98	1.00	1.00	0.97	0.98	0.95	0.95
0.58	0.58	0.98	0.98	0.98	0.98	0.90	0.90	0.91	0.91	0.89	0.89
0.17	0.16	0.07	0.07	0.98	0.98	0.01	0.01	0.91	0.91	0.12	0.12
0.58	0.58	0.04	0.03	0.99	0.99	0.09	0.08	0.58	0.58	0.76	0.77
0.97	0.98	0.03	0.03	0.98	0.99	0.80	0.81	0.95	0.95	0.95	0.95
0.89	0.89	0.78	0.79	0.99	0.99	0.96	0.96	0.31	0.31	0.05	0.05
0.04	0.04	0.10	0.09	0.13	0.13	0.36	0.36	0.43	0.43	0.07	0.06
0.08	0.07	0.17	0.16	0.88	0.88	0.08	0.07	0.13	0.13	0.42	0.42
0.72	0.72	0.05	0.05	0.98	0.98	0.01	0.01	0.95	0.95	0.91	0.92
0.34	0.34	0.10	0.10	0.42	0.41	0.47	0.47	0.58	0.58	0.05	0.05
0.98	0.98	1.00	1.00	0.99	0.99	0.94	0.94	0.99	0.99	0.95	0.95
0.02	0.02	0.18	0.17	0.59	0.59	0.00	0.00	0.00	0.00	0.12	0.12
0.01	0.01	0.02	0.02	0.01	0.01	0.12	0.11	0.01	0.01	0.05	0.05
0.01	0.01	0.04	0.03	0.17	0.17	0.01	0.00	0.84	0.84	0.21	0.21
0.03	0.03	0.30	0.30	0.09	0.09	0.21	0.21	0.21	0.20	0.07	0.06
0.95	0.95	0.13	0.13	0.99	0.99	0.66	0.67	0.91	0.91	0.95	0.95
0.98	0.98	0.99	0.98	0.99	0.99	1.00	1.00	0.97	0.98	0.95	0.95

something very unusual was considered, it was likely the normal distribution. The logistic distribution has wider tails than the normal distribution, but when adjusted for width, it becomes almost indistinguishable from the normal distribution.

The reason the commentator chose the logit transformation is likely because it deals with the degree (probability) of something being binary, and the logit transformation is based on binary logic. However, the two probability distributions are almost the same, and choosing either would probably make no difference in the results. The author of the guidebook might have used the normal distribution. In this explanation, we will use the probabilities calculated using the logit transformation as membership values for subsequent analyses. However, for reference, I will also describe the calculation method using the normal distribution. This is known as the probit transformation. In Excel, we use the inverse function of the normal distribution, NORM.INV. It is taught that approximately 95% of the normal distribution falls within the range of ±2σ (1.96) from the center. Since this is two-sided, using the inverse function of the normal distribution in Excel with a mean of 0 and a standard deviation of 1, the distance from the center at a probability of 0.95 is 1.64. For example, for the upper side of A's richness:

$$d = 1.64 \times \frac{x}{900 - 550}$$

By proportionally distributing this through linear regression, we can find the standardized distance from the center. Using Excel's normal distribution probability density function NORM.DIST with d, a mean of 0, and a standard deviation of 1, we can calculate the cumulative probability. This will be used as the membership value.

$$d = 1.64 \times \frac{x}{900 - 550}$$

IV-2-2. Sufficient Conditions and Consistency in Fuzzy Sets

In the case of sets, if set A is a subset of set B, then set A is a sufficient condition for set B, and set B is a necessary condition for set A. This is evident when drawing a Venn diagram. It is difficult to consider the inclusion relationship of two conditions based on the “degree” to which they meet the conditions, rather than as sets.

As done in csQCA, if we think in binary logic about whether something meets a criterion or not, the inclusion relationship between conditions A and B is a comparison of the criteria for judging their suitability. If the criteria for determining condition A are $\alpha, \beta, \gamma, \delta, \varepsilon$ and the criteria for determining condition B are α, β, γ then:

$$A = \alpha \wedge \beta \wedge \gamma \wedge \delta \wedge \varepsilon$$

$$B = \alpha \wedge \beta \wedge \gamma$$

Thus,

$$A = B \wedge \delta \wedge \varepsilon$$

Therefore, B is absolutely necessary for A to hold, making B a necessary condition for A. If A holds, regardless of δ and ε, B will also hold, making A a sufficient condition for B.

$$A \subseteq B$$

In this case, the “degree” to which A applies, membership value: $\mu(A)$ must also meet the criteria of δ and ε ins (membership value: $\mu(B)$), so $\mu(A)$ will be smaller than $\mu(B)$. This is the same even in the case of the negation of δ or ε. Therefore, regardless of the value of $\mu(B)$. if $A \subseteq B$, $\mu(A)$will always be smaller than μ(B) for any data.

$$A \subseteq B \Rightarrow \mu(A) \leq \mu(B)$$

If this sign relationship consistently holds, it is reasonable to think that the condition with the smaller membership function is a sufficient condition for the condition with the larger membership function. In practice, since membership score are determined fuzzily for individual conditions, it cannot always be said that the membership score is larger for necessary conditions. Therefore, there should be statistical criteria for determining how much difference and how many cases are needed to make such claims, but that discussion is left to other texts.

Before that, there is the issue of whether it is appropriate to handle membership functions in such a manner. In the approach presented here, I have inferred the method they likely used to determine the membership values for the sake of this explanation. This inference is probably almost correct. They consider a type of probability distribution as the membership values. Probability distributions range from 0 to 1. The degree of fitness should be distributed within a narrower range than 0 to 1. If this is used as membership values, there is a possibility of inversion of membership values even in the case of inclusion relationships. Nevertheless, if the relative consistency is high, there is a way of thinking that acknowledges the inclusion relationship. For that, an index that can relatively evaluate consistency is necessary. Next, I will present an evaluation and comparative analysis method for consistency and coherence. Figure 24 shows the distribution of membership values in cases where there is an inclusion relationship （$A \subseteq B$） and where there is not ($A \nsubseteq C$). α , β , γ , δ and ε are the IDs of the data.A scatter plot was created with the membership of condition A on the horizontal axis and the membership values of conditions B and C on the vertical axis, showing the membership values of conditions B and C for each data ID. The diagonal line in the figure represents the line where $\mu(A) = \mu(B) = \mu(C)$. For IDs plotted above this line,

$$\mu(A) \leq \mu(B), \quad \mu(A) \leq \mu(C)$$

The values of $\mu(C)$shown in red in the figure are for IDs β , δ and ε which are below $\mu(A)$, but $\mu(B)$ consistently exceeds $\mu(A)$ for all IDs. From this, it can be judged that there is a high possibility of an inclusion relationship between conditions A and B, i.e., $A \subseteq B$.

Table 17 is a summary table for evaluating consistency. The numerical values in the table are membership values, and the bottom row is their total. On the right side, the membership values that are smaller when comparing A-B, the smaller membership values when comparing A-C, and their totals are shown. The evaluation of consistency is done by the ratio of each total to the total of $\mu(A)$. The larger the value, the higher the consistency and coherence of the inclusion relationship, with the maximum value

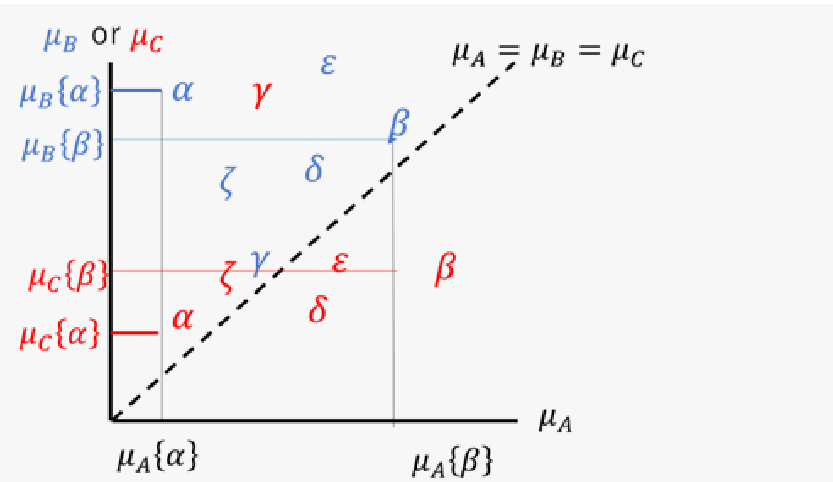

Fig. 24. Inclusion relationship between A-B and A-C

Table 17. Caluculation table for consistency value

	A	B	C	Min(A,B)	Min(A,C)
	0.20	0.90	0.30	0.20	0.20
	0.70	0.80	0.40	0.70	0.40
	0.40	0.90	0.90	0.40	0.40
	0.50	0.70	0.30	0.50	0.30
	0.75	0.95	0.40	0.75	0.40
	0.30	0.70	0.40	0.30	0.30
Sum	2.85	4.95	2.70	2.85	2.00

being 1. The calculation formula is written as follows:

$$Consistency(A \subset B) = \frac{\sum \min\left(\mu(A), \mu(B)\right)}{\sum \mu(A)}$$

Specifically, for the summary in Table 17:

$$Consistency(A \subset B) = \frac{2.85}{2.85} = 1$$

$$Consistency(A \subset C) = \frac{2.00}{2.85} = 0.70$$

IV-3. Attempting fsQCA

IV-3-1. Analysis of Interwar Europe

Using the cumulative probabilities calculated by the commentator (Table 16) as membership score, fsQCA was conducted. Table 18 shows the calculation process of the consistency and coherence of the inclusion relationship between the result R (maintenance of democracy) and the logical product $A \wedge B \wedge C \wedge D \wedge E$. The column $A * B * C * D * E$ represents the minimum score of conditions (A, B, C, D, E) for each country, which becomes the membership score of the logical product condition $A \wedge B \wedge C \wedge D \wedge E$. The column c represents the smaller value between the membership score of $A \wedge B \wedge C \wedge D \wedge E$ and the membership score of the result R. These values are summed vertically in each column to obtain their ratio, which becomes the consistency value. In the table, the countries marked in yellow are those where including Belgium, Czechoslovakia, the Netherlands, and the United Kingdom. This result is consistent with the results of csQCA. The countries marked in pink are those where the membership value of the logical product exceeds the membership value of the result (R), resulting in a consistency value that is not 1. These countries include Austria, Germany, and Italy. This calculation is performed for all combinations of (A, B, C, D, E) and their negations (a, b, c, d, e).

There are 32 cases included in (R) (maintenance of democracy) and 32 cases of democratic collapse, making a total of 64 cases. These assumptions are left in

Table 18. Calculation of consistency of $A \wedge B \wedge C \wedge D \wedge E \rightarrow R$

	A	B	C	D	E	A*B*C*D*E	R	c	
AUT	0.81	0.12	0.99	0.73	0.43	0.12	0.05	0.05	
BEL	0.99	0.89	0.98	1.00	0.97	0.89	0.95	0.89	
CZE	0.58	0.98	0.98	0.90	0.91	0.58	0.89	0.58	
EST	0.17	0.07	0.98	0.01	0.91	0.01	0.12	0.01	
FIN	0.58	0.04	0.99	0.09	0.58	0.04	0.76	0.04	
FRA	0.97	0.03	0.98	0.80	0.95	0.03	0.95	0.03	
GER	0.89	0.78	0.99	0.96	0.31	0.31	0.05	0.05	
GRC	0.04	0.10	0.13	0.36	0.43	0.04	0.07	0.04	
HUN	0.08	0.17	0.88	0.08	0.13	0.08	0.42	0.08	
IRL	0.72	0.05	0.98	0.01	0.95	0.01	0.91	0.01	
ITA	0.34	0.10	0.42	0.47	0.58	0.10	0.05	0.05	
NLD	0.98	1.00	0.99	0.94	0.99	0.94	0.95	0.94	
POL	0.02	0.18	0.59	0.00	0.00	0.00	0.12	0.00	
PRT	0.01	0.02	0.01	0.12	0.01	0.01	0.05	0.01	
ROU	0.01	0.04	0.17	0.01	0.84	0.01	0.21	0.01	
ESP	0.03	0.30	0.09	0.21	0.21	0.03	0.07	0.03	
SWE	0.95	0.13	0.99	0.66	0.91	0.13	0.95	0.13	
UK	0.98	0.99	0.99	1.00	0.97	0.97	0.95	0.95	
						4.29		3.88	0.904997 UK(0.97),NLD(0.94),BEL(0.89),CZE(0.58)

$min(A, B, C, D, E)$

$\min(A \wedge B \wedge C \wedge D \wedge E, R)$

$$consistency(A \wedge B \wedge C \wedge D \wedge E \subset R) = \frac{\sum \min(A \wedge B \wedge C \wedge D \wedge E, R)}{\sum min(A, B, C, D, E)} = \frac{3.88}{4.29} = 0.905$$

Countries mor than 0.50

Excel.consist. Using Table 18, the aggregation and calculation procedures are confirmed. The column $A * B * C * D * E$ represents the membership scores of the logical product of A, B, C, D and E, and the minimum values of A, B, C, D, E are entered. The column R represents the result column, where the membership scores of R are entered. The column c represents the membership scores of the logical product and the result, where the smaller value between the membership score of the logical product A, B, C, D, E and the membership score of the result is entered. The sum of these values along the column is 4.29 and 3.88 at the bottom, and their ratio is the consistency value of 0.905. Using the same aggregation table, the consistency of the inclusion relationship $A \wedge B \wedge C \wedge D \wedge E \rightarrow r$ (the negation of R, democratic collapse) is evaluated (Table 19). In Belgium, the Czechslovakia, the Netherlands, Sweden, and the United Kingdom, the membership values of the logical product $A \wedge B \wedge C \wedge D \wedge E$ exceed the membership values of r, resulting in a very small consistency value of 0.255. This means that it is almost impossible for these countries to result in democratic collapse (there is almost no overlap with the set r).

Summarizing the results of repeating this aggregation and calculation 32 times for R and r, we obtain Tables 20 and 21. The leftmost column of the table shows the combinations of individual conditions, the five columns to the right of it show the binary truth table with a cumulative probability of 0.50 (using the same value as the boundary value, so it is the same as the csQCA truth table), the consistency column

Table 19. Calculation of consistency of $A \wedge B \wedge C \wedge D \wedge E \rightarrow r$

	A	B	C	D	E	A*B*C*D*E	r	c		
AUT	0.81	0.12	0.99	0.73	0.43	0.12	0.95	0.12		
BEL	0.99	0.89	0.98	1.00	0.97	0.89	0.05	0.05		
CZE	0.58	0.98	0.98	0.90	0.91	0.58	0.11	0.11		
EST	0.17	0.07	0.98	0.01	0.91	0.01	0.88	0.01		
FIN	0.58	0.04	0.99	0.09	0.58	0.04	0.24	0.04		
FRA	0.97	0.03	0.98	0.80	0.95	0.03	0.05	0.03		
GER	0.89	0.78	0.99	0.96	0.31	0.31	0.95	0.31		
GRC	0.04	0.10	0.13	0.36	0.43	0.04	0.93	0.04		
HUN	0.08	0.17	0.88	0.08	0.13	0.08	0.58	0.08		
IRL	0.72	0.05	0.98	0.01	0.95	0.01	0.09	0.01		
ITA	0.34	0.10	0.42	0.47	0.58	0.10	0.95	0.10		
NLD	0.98	1.00	0.99	0.94	0.99	0.94	0.05	0.05		
POL	0.02	0.18	0.59	0.00	0.00	0.00	0.88	0.00		
PRT	0.01	0.02	0.01	0.12	0.01	0.01	0.95	0.01		
ROU	0.01	0.04	0.17	0.01	0.84	0.01	0.79	0.01		
ESP	0.03	0.30	0.09	0.21	0.21	0.03	0.93	0.03		
SWE	0.95	0.13	0.99	0.66	0.91	0.13	0.05	0.05		
UK	0.98	0.99	0.99	1.00	0.97	0.97	0.05	0.05		
						4.29		1.09	0.25512	UK(0.97),NLD(0.94),BEL(0.89),CZE(0.58)

Table 20. Consistencies of inclusion relationship between R and logical product of 5 conditions

set	A	B	C	D	E	consist	country
A*B*C*D*E	1	1	1	1	1	0.904997	UK(0.97),NLD(0.94),BEL(0.89),CZE(0.58)
A*b*C*d*E	1	0	1	0	1	0.805562	IRL(0.72),FIN(0.58)
A*b*C*D*E	1	0	1	1	1	0.706196	FRA(0.80),SWE(0.66)
a*b*C*d*E	0	0	1	0	1	0.538335	EST(0.83)
a*b*C*d*e	0	0	1	0	0	0.529202	HUN(0.83),POL(0.59)
A*B*C*D*e	1	1	1	1	0	0.458506	GER(0.69)
A*b*C*D*e	1	0	1	1	0	0.390327	AUT(0.57)
a*b*c*d*E	0	0	0	0	1	0.288745	ROU(0.53),ITA(0.53)
a*b*c*d*e	0	0	0	0	0	0.226152	PRT(0.88),ESP(0.70),GRC(0.57)

Table 21. Consistencies of inclusion relationship between r and logical product of 5 conditions

set	A	B	C	D	E	consisten	country
a*b*c*d*e	0	0	0	0	0	1.000000	PRT(0.88),ESP(0.70),GRC(0.57)
a*b*c*d*E	0	0	0	0	1	0.982947	ROU(0.53),ITA(0.53)
A*b*C*D*e	1	0	1	1	0	0.973859	AUT(0.57)
A*B*C*D*e	1	1	1	1	0	0.970318	GER(0.69)
a*b*C*d*E	0	0	1	0	1	0.867368	EST(0.83)
a*b*C*d*e	0	0	1	0	0	0.861862	HUN(0.83),POL(0.59)
A*b*C*d*E	1	0	1	0	1	0.506256	IRL(0.72),FIN(0.58)
A*b*C*D*E	1	0	1	1	1	0.502799	FRA(0.80),SWE(0.66)
A*B*C*D*E	1	1	1	1	1	0.25512	UK(0.97),NLD(0.94),BEL(0.89),CZE(0.58)

shows the consistency values obtained as calculation results, and the rightmost column, country, shows the countries belonging to those conditions, with the values in parentheses after the country names indicating the membership values of the logical product conditions for each country. Table 20 shows the inclusion relationship between the result R (maintenance of democracy) and the logical product conditions, while Table 21 shows the inclusion relationship between the result r (collapse of democracy) and the logical product conditions. In Table 20, all the countries maintaining democracy are at the top, and in Table 21, all the countries where democracy has collapsed are at the top. Additionally, in both tables, the consistency values differ significantly between the countries maintaining democracy and those where democracy has collapsed. Furthermore, the membership values of the logical product conditions for the countries belonging to each combination all exceed 0.50. In other words, these results are completely consistent with the csQCA results. These results are the initial solution.

Minimizing the initial solution: From the csQCA results, it appears that conditions B and D can be removed without issue. Therefore, the examination of the membership values of the logical product of the three conditions A, C, and E, and their inclusion relationships with R and r, resulted in Tables 22 and 23. In Table 22, the logical

Table 22. Consistencies of inclusion relationship between R and logical product of 3 conditions

	A	C	E	consisten	country
A*C*E	1	1	1	0.869338	NLD(0.98),UK(0.97),BEL(0.97).FIN(0.95),SWE(0.91),(RL(0.72),FIN(0.58)CZE(0.58)
a*C*E	0	1	1	0.589501	EST(0.83)
a*C*e	0	1	0	0.589501	HUN(0.87),POL(0.59)
A*c*e	1	0	0	0.566973	Ø
A*c*E	1	0	1	0.552607	Ø
A*C*e	1	1	0	0.451675	GER(0.69),AUT(0.57)
a*c*E	0	0	1	0.286804	ROM(0.83),ITA(0.58)
a*c*e	0	0	0	0.216667	PRT(0.99),ESP(0.79),GRC(0.57)

Table 23. Consistencies of inclusion relationship between r and logical product of 3 conditions

	A	C	E	cosistency	country
A*c*E	1	0	1	1	Ø
A*c*e	1	0	0	1	Ø
a*c*e	0	0	0	0.9896	PRT(0.99),ESP(0.79),GRC(0.57)
a*c*E	0	0	1	0.983436	ROM(0.83),ITA(0.58)
A*C*e	1	1	0	0.914792	GER(0.69),AUT(0.57)
a*C*E	0	1	1	0.794186	EST(0.83)
a*C*e	0	1	0	0.589501	HUN(0.87),POL(0.59)
A*C*E	1	1	1	0.260589	NLD(0.98),UK(0.97),BEL(0.97).FIN(0.95),SWE(0.91),(RL(0.72),FIN(0.58)CZE(0.58)

product of the three conditions A (wealthy), C (high education level), and E (politically stable), denoted as $A \wedge C \wedge E$(wealthy, highly educated, and politically stable), is included in R (maintenance of democracy) with a consistency of 0.869. Including the logical remainder (empty set), all other combinations have a consistency of 0.590 or less, showing a clear difference. From this, it can be said that$A \wedge C \wedge E$ is the only sufficient condition for R among these combinations. On the other hand, in Table 23, the consistency of the combination of A, C, and E was 0.261, while all other combinations, including the logical remainder (empty set), had a consistency of 0.50 or higher. If a consistency of 0.50 or higher is considered a sufficient condition for r, then all combinations other than A, C, and E become sufficient conditions for r, meaning that democracy collapses if a country is not wealthy, highly educated, and politically stable. The conclusion of the examination of the inclusion relationships of the three conditions is

$$A \wedge C \wedge E \rightarrow R$$

This is one of the intermediate solutions.

Table 24 shows the analysis results regarding the consistency of combinations of two conditions being included in the result R. Among the combinations of A (wealth) and C (education level), the combination $A \wedge C$ (wealthy and highly educated) had a relatively

Table 24. Consistencies of inclusion relationship between R and logical product of 2 conditions

	A	C	consistter	country
A＊C	1	1	0.776021	AUT(0.81)BEL(0.98)SZE(0.58)FIN(0.58)FRA(0.97)GER(0.89)IRL(0.72)NLD(0.98)SWE(0.95)UK(0
A＊c	1	0	0.567066	Ø
a＊C	0	1	0.509065	EST(0.83)HUN(0.88)POL(0.59)
a＊c	0	0	0.171283	GRC(0.8 7)ITA(0.58)PRT(0.99)ROU(0.83)ESP(0.91)
	C	E	consistter	country
C*E	1	1	0.793715	BEL(0.97)CZE((0.91)EST(0.91)FIN(0.58)FRA(0.95)IRL(0.95)NLD(0.99)SWE(0.91)UK(0.97)
C*e	1	0	0.423538	AUT(0.57)GER(0.69)HUN(0.87)POL(0.599
c*E	0	1	0.290442	ITA(0.58)ROU(0.83)
c*e	0	0	0.219244	GRC(0.57)PRT(0.99)ESP(0.79)
	A	E	consistter	country
A*E	1	1	0.869338	BEL(0.97)CZE(0.58)FIN(0.58)FRA(0.95IRL(0.92)NLD(0.98)SWE(0.91)UK(0.93)
A*e	1	0	0.451675	AUT(0.57)GER(0.69)
a*E	0	1	0.438146	EST(0.83)ITA(0.58)ROU(0.83)
a＊e	0	0	0.308385	GRC(0.57)HUN(0.87)POL(0.98)PRT(0.99)ESP(0.79)

Table 25. Consistencies of inclusion relationship between r and logical product of 2 conditions

			r	
	A	C	consistter	country
A＊c	1	0	1	Ø
a＊c	0	0	0.984351	GRC(0.8 7)ITA(0.58)PRT(0.99)ROU(0.83)ESP(0.91)
a＊C	0	1	0.789931	EST(0.83)HUN(0.88)POL(0.59)
A＊C	1	1	0.336996	AUT(0.81)BEL(0.98)SZE(0.58)FIN(0.58)FRA(0.97)GER(0.89)IRL(0.72)NLD(0.98)SWE(0.95)UK(0.98)
	C	E	consistter	country
c＊e	0	0	0.989634	GRC(0.57)PRT(0.99)ESP(0.79)
c*E	0	1	0.983521	ITA(0.58)ROU(0.83)
C*e	1	0	0.883534	AUT(0.57)GER(0.69)HUN(0.87)POL(0.599
C*E	1	1	0.331411	BEL(0.97)CZE((0.91)EST(0.91)FIN(0.58)FRA(0.95)IRL(0.95)NLD(0.99)SWE(0.91)UK(0.97)
	A	E	consistter	country
A*e	1	0	0.914792	AUT(0.57)GER(0.69)
a＊e	0	0	0.895423	GRC(0.57)HUN(0.87)POL(0.98)PRT(0.99)ESP(0.79)
a*E	0	1	0.839113	EST(0.83)ITA(0.58)ROU(0.83)
A*E	1	1	0.260589	BEL(0.97)CZE(0.58)FIN(0.58)FRA(0.95IRL(0.92)NLD(0.98)SWE(0.91)UK(0.93)

high consistency value (0.776). However, this condition included countries where democracy has collapsed, such as Austria and Germany, indicating that being wealthy and highly educated is not a sufficient condition for maintaining democracy. In the combination of C (education level) and E (political stability), the condition $C \wedge E$ (highly educated and politically stable) also showed a relatively high consistency value, but it included Estonia, a country where democracy has collapsed, suggesting that this combination is also not a sufficient condition for maintaining democracy. The combination of A (wealth) and E (political stability) yielded the highest consistency value (0.869) for $A \wedge E$ (wealthy and politically stable), and all countries meeting this condition were those maintaining democracy, with no countries where democracy had collapsed. Therefore, being wealthy and politically stable is considered a sufficient condition for maintaining democracy.

Table 25 shows the examination results of the inclusion relationships between combinations of two conditions and the result r (collapse of democracy). The inclusion relationships for r showed high consistency values (0.80 or higher) for almost all combinations except for $A \wedge E$ (wealthy and politically stable). The exception was $a \wedge C$ (poor and highly educated) with a consistency value of 0.79, which is still sufficiently high compared to the consistency value of $A \wedge E$. Moreover, none of these combinations included countries maintaining democracy. Therefore, $\widetilde{A \wedge E} \longrightarrow r$, meaning that considering the conditions of A (wealth) and E (political stability), all countries that are not wealthy or not politically stable will see democracy collapse.

The conclusion here is

$$A \wedge E \longrightarrow R, \quad \widetilde{A \wedge E} \rightarrow r = \tilde{R}$$

The conditions for maintaining democracy and the collapse of democracy are completely complementary.

Next, we consider one condition. Table 26 shows the consistency values and the countries belonging to each condition. In the inclusion relationship with R (maintenance of democracy), the consistency values for $A \subseteq R$, $C \subseteq R$ and $E \subseteq R$ are low, and both democratic and non-democratic countries are included in the conditions A, C, and E. Conversely, in the inclusion relationship with r (collapse of democracy), the consistency values are high for all inclusion relationships, and all non-democratic countries except Germany are included. From this, the inclusion relationships $a \subseteq r$, $c \subseteq r$ and $e \subseteq r$ are recognized, and the relationships $a \longrightarrow r$, $c \longrightarrow r$ and $e \longrightarrow r$ are established. In other words, r (collapse of democracy) is a necessary condition for a (poverty), c (low education level), and e (political instability), and a (poverty), c (low education level), and e (political instability) are each sufficient conditions for r (collapse of democracy). In everyday language, this means that “countries that are poor, have low education levels, or are politically unstable” will “experience a collapse of democracy.” Among these, it is noteworthy that the consistency value of $c \subseteq r$ is high.

It can be concluded that countries with low education levels will almost certainly experience a collapse of democracy.

Table 26. Consistencies of inclusion relationship between the results and 3 single conditions

Inclusion	Consist.	Countries	Inclusion	Consist.	countries
$A \subseteq R$	0.775	AUT,BEL,CZE,FIN, FRA,GER,IRL, NLD,SWE, UK	$a \subseteq r$	0.837	EST,GRC,HUN,ITA, POL,PRT,ROU,ESP
$C \subseteq R$	0.643	AUT,BEL,CZE,EST,FIN, FRA,GER,HUN,IRL, NLD, POL, SWE, UK	$c \subseteq r$	0.984	GRC,ITA,PRT,ROU, ESP
$E \subseteq R$	0.708	BEL,CZE, EST, FIN, FRA.IRL,ITA,NLD, ROU, SWE, UK	$e \subseteq r$	0.902	AUT,GER,GRC,HUN, POL, PRT, ESP

Meanwhile, rewriting the result

$$a \vee c \vee e \rightarrow r$$

as

$$\tilde{A} \vee \tilde{C} \vee \tilde{E} \rightarrow \tilde{R}$$

applying De Morgan's law,

$$\tilde{A} \vee \tilde{C} \vee \tilde{E} = A \widetilde{\wedge C \wedge} E \rightarrow \tilde{R}$$

The result of examining the three conditions is

$$A \wedge C \wedge E \rightarrow R$$

In logical operations, the reverse is not necessarily true, but in this case, the complementary relationship matches. This conclusion applies to all 18 countries, with a coverage of 1.00. Similarly, the conclusion for two conditions,

$$A \wedge E \rightarrow R$$

and

$$a \vee e \rightarrow r$$

both formulas are complementary and the reverse is true. As an overall conclusion, focusing on the three-condition formula,

$$A \wedge C \wedge E \longrightarrow R$$

$$A \widetilde{\wedge C \wedge} E \longrightarrow r$$

It can be concluded that if A (wealthy), C (high education level), and E (stable government) are present, democracy will not collapse. Otherwise, democracy will collapse. Alternatively, adopting the analysis result of the two conditions, it can be concluded that if A (wealthy) and E (stable government) are present, democracy will not collapse. Otherwise, democracy will collapse. This conclusion also has a coverage of 1.00. It is difficult to decide which to adopt as the final conclusion. Both are perfect conclusions considering the coverage.

In this case, concluding

$$A \wedge E \longrightarrow R$$
$$\widetilde{A \wedge E} \longrightarrow r$$

as a more parsimonious expression would ignore the high consistency (degree of certainty) of $c \to r$. One way to draw a conclusion is to consider A and E as core conditions and C as a peripheral condition, separately indicating the high value of C and pointing out its importance. This value is likely to be quite high. The above is the conclusion of the fsQCA trial, and the purpose of this analysis was to verify Lipset's theory that "modernization promotes democracy." In this case, the question arises as to what modernization is, but the aspects of modernization are likely urbanization and industrialization. In our analysis, using the csQCA analysis results, B (urbanization level) and D (industrialization level) were excluded from the analysis targets, so the relationship between B (urbanization level), D (industrialization level), and democracy was not analyzed. In the next section, we will analyze B and D and verify Lipset's theory.

IV-3-2. Verification of Lipset's Theory

Of course, I have no intention of criticizing or evaluating the theory of the renowned political scientist Lipset, who quantitatively discussed the relationship between politics and the economy/society. In the first place, I have never read his papers or books. Moreover, I have not confirmed whether the data used for analysis was taken from his works. Probably, the data on political stability was added by someone later. Based on this premise, I will proceed with a more detailed analysis using the given data. This is the commentator's original work.

If modernization in Europe is a consequence of the Industrial Revolution, its content is the change in the industrial structure of the entire society, naturally accompanied by "industrialization" and "urbanization." "Increase in wealth" and "spread of education" are likely the results of this. It is not that "increase in wealth" and "spread of education" led to "industrialization" and "urbanization." In the previous section, using the csQCA method, I proceeded with the analysis by removing the data for B (urbanization) and D (industrialization). In this section, I will focus on B (urbanization) and D (industrialization) and conduct fsQCA.

Table 27 shows the consistency of the logical product of factors B and D being included in results R and r. The consistency of the inclusion relationship $B \wedge D \subseteq R$ is relatively high at 0.789. Numerically, it can be said that countries that have urbanized (B) and industrialized (D) tend to maintain democracy. However, since Germany is included in this category, it cannot be said that urbanized and industrialized countries will inevitably avoid the collapse of democracy. The consistency of being included in r (collapse of democracy) was high for $B \wedge d \subseteq r$, which means that countries that urbanized without industrializing tend to experience the collapse of democracy.

Table 27. Consistencies of inclusion relationship between the results and logical products of 2 conditions

⊆R	B	D	consistency	country
B*D	1	1	0.798205125	BEL(0.89)CZE(0.90)GER(0.78)NLD(0.94)UK(0.99)
B*d	1	0	0.714445847	Ø
b*D	0	1	0.54739277	AUT(0.73)FRA(0.80)SWE(0.63)
b*d	0	0	0.382152211	EST(0.92)FIN(0.91)GRC(0.64)HUN(0.83)IRL(0.95)ITA(0.53)POL(0.82)PRT(0.88)ROU(0.96)ESP(0.70)
⊆r	B	D	consistency	country
B*d	1	0	0.940622807	Ø
b*d	0	0	0.728426697	EST(0.92)FIN(0.91)GRC(0.64)HUN(0.83)IRL(0.95)ITA(0.53)POL(0.82)PRT(0.88)ROU(0.96)ESP(0.70)
b*D	0	1	0.634993824	AUT(0.73)FRA(0.80)SWE(0.63)
B*D	1	1	0.339592079	BEL(0.89)CZE(0.90)GER(0.78)NLD(0.94)UK(0.99)

Although this consistency is extremely high at 0.94, this combination is an empty set. Since the cause of urbanization is population concentration due to industrialization, the possibility of such countries existing is low, and indeed, there are no such examples.

A more likely combination is $b \wedge d$ (neither industrialized nor urbanized). However, the consistency of this combination being included in r ($b \wedge d \subseteq r$) is not sufficiently high at 0.73. There are 10 countries that belong to this combination, of which 8 are countries where democracy has collapsed, but Finland and Ireland, which have maintained democracy, are also included. Therefore, $b \wedge d \subseteq r$ or $b \wedge d \longrightarrow r$ is denied. In other words, there are countries (Finland and Ireland) that have maintained democracy even though they are neither urbanized (b) nor industrialized (d).

Table 28 shows the consistency of the inclusion relationship between the single conditions B and D and the results. Although $B \subseteq R$ has relatively high consistency, it includes Germany, a country where democracy has collapsed, thus $B \subseteq R$, i.e., the notion that urbanized countries maintain democracy, is denied. All other inclusion relationships also have low consistency and include countries with different outcomes. In other words, neither B, D, nor their negations b, d are conditions that are solely included in the results. Adding this result to the examination of the two conditions mentioned earlier, neither B, D, nor their negations b, d, whether alone or combined, explain the maintenance or collapse of democracy. Rather, wealth, education level, and political stability determine the fate of democracy in a country.

Table 28. Consistencies of inclusion relationship between the results and 2 single conditions

Inclusion	Consist.	Countries	Inclusion	Consist.	Countries
$B \subseteq R$	0.773	BEL,CZE,GER, NLD,UK	$b \subseteq r$	0.675	AUT,EST,FIN,FRA GRC,HUN,IRL,ITA POL,PRT,ROU, ESP,SWE,
$D \subseteq R$	0.686	AUT,BEL,CZE, FRA,GER,NLD, SWE,UK	$d \subseteq r$	0.371	EST,FIN,GRC, HUNIRL,ITA, POL,PRT, ROU,ESP

What should be questioned here is the content of “modernization” as stated by Lipset. If becoming wealthy, raising the level of education, and stabilizing politics are interpreted as results of modernization, then Lipset’s theory is affirmed. However, if urbanization and industrialization are what modernization means, then it cannot be concluded that modernization alone made it possible to maintain democracy. If the Industrial Revolution is a change in social structure accompanying changes in industrial structure, and modernization is its consequence, then industrialization and urbanization are modernization itself, and becoming wealthy or raising the level of education are its results. Wealth and education levels are influenced by factors other than modernization. Considering this, Lipset’s theory should be denied.

IV-4. Summary and Additional Remarks on fsQCA (Completely Unrelated Commentary)

Summary

1. As a result of analyzing the data from interwar Europe using fsQCA, it was found that wealthy countries with high education levels and political stability were able to maintain democracy, while those that did not have these attributes saw the collapse of democracy. This result was consistent with the findings from factor analysis.
2. The fsQCA results also showed that wealthy and politically stable countries could maintain democracy, while those that were not saw the collapse of democracy. Along with the results from point 1, these findings were consistent with the results from csQCA.
3. The calculation of consistency using membership score made it possible to numerically capture the likelihood of inclusion relationships (sufficient conditions). However, the threshold for consistency values was ambiguous, and it was necessary to refer to the results of csQCA for the determination of inclusion relationships. Moreover, since membershipscores are arbitrarily determined, it cannot be said that fsQCA increased explanatory power.
4. Quantitative analysis showed that Austria, Czechoslovakia, Finland, Germany, and Ireland belonged to the boundary region, even with discrepancies in MDS, principal component analysis, cluster analysis, and factor analysis. Similar conclusions could be drawn using QCA, but quantitative analysis could demonstrate this more simply and clearly.
5. Factor analysis and regression analysis showed that urbanization and industrialization could explain the maintenance of democracy by complementing wealth, education level, and political stability. However, the significance (necessity) of explaining these two separately remained questionable. The examination of the inclusion relationships (whether they are sufficient conditions) of these and their combined conditions using fsQCA resulted in ambiguous consistency values, leading to the conclusion that they cannot be definitively said to be sufficient conditions. This was consistent with the results of factor analysis and regression analysis, suggesting that these conditions, while weak in explanatory power alone, independently explain the results by complementing wealth, education level, and political stability. This was made possible by fsQCA.

Additional Remarks Lipset's theory is based on examples from Europe and the United States. The most historically significant outcome of World War II was the independence of colonies. As a result of independence, various countries were born, some of which succeeded in introducing and establishing democratic systems, while others became dictatorships. For some reason, the analysis of such cases does not seem to have progressed in political science, and Lipset's theory of "modernization: promotion of democracy" remains an important theory in political science.

When I was a child, I learned in elementary school social studies that "North Korea is an industrial country and economically developed, while South Korea is an agricultural country and economically backward." At that time, the influence of the Japan Teachers' Union was strong, and textbooks were also influenced by it, so I do not know if this was true. If it was true, North Korea would have quickly declined by squandering the legacy of its predecessors. Be that as it may, it is true that North Korea was an industrial country and South Korea (South Korea) was an agricultural country at that time. During the annexation period, Japan industrialized North Korea by building the Supung Dam on the Yalu River and using its electricity to produce nitrogen fertilizers, while promoting agricultural development in South Korea. At the end of World War II, North Korea was wealthy and industrialized, while South Korea was a poor agricultural area. Koreans living in Korea did not have the right to vote in Japan, but Koreans living in Japan were granted suffrage, and members of local councils (or something similar) were elected by vote. Although the right to stand for election was limited to certain taxpayers, most of the council members were Koreans. In other words, a foundation for democracy was partially established. Nevertheless, democracy did not take root in North Korea, and it became a dictatorship under the Kim family. On the other hand, although South Korea (South Korea) experienced the dictatorship of Syngman Rhee, with the help of Japan (it is incorrect to call this compensation. Korea was annexed by Japan and was not a belligerent country. Therefore, it has no right to claim compensation as a victorious country), it achieved economic development through the Miracle on the Han River and established a democratic political system.

This is a remarkable contrast and a kind of social experiment. Regardless of the appropriateness of the expression, this is a historical fact. If so, wealth, industrialization, and so-called modernization did not contribute to the development of democracy. The collapse of democracy in North Korea and the formation of democracy in South Korea are more likely to be understood as a result of the geopolitical positioning of the Korean Peninsula in the context of the conflict between China and the Soviet Union versus the United States. It is more realistic and contemporary to understand that democracy in developing countries is determined by the geopolitical positioning of the country in international politics.