

Necessary and Sufficient Conditions for Bank Participation in Multi-stakeholder Agreements: A Formal Concept Analysis

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Abstract. The paper uses Formal Concept Analysis (FCA) to replicate the results of a study that employed fuzzy set Qualitative Comparative Analysis (fsQCA) to determine the configurational conditions that are necessary or sufficient to explain the participation of top banks in a multi-stakeholder agreement against money laundering. Using raw input data from a previous study, the same result regarding necessary conditions was reached using FCA, showing that FCA can be reliably used for this kind of analysis. However, differences in scaling method resulted in the identification of sufficient conditions that differed from those of the original fsQCA study.

Keywords: FCA, fsQCA, corporate responsibility, Wolfsberg Standards, banking regulation

1 Introduction

In the wake of money laundering scandals that dogged international banks at the turn of the century, a few leading banks drew up a voluntary agreement in 1999 consisting of a number of standards aimed at preventing the use of the global reach of the international banking system for criminal purposes. The initial meetings took place at Château Wolfsberg in Switzerland and accordingly the signatories are known as the Wolfsberg Group and their agreed-upon principles as the Wolfsberg Standards. The group, existing of 11 leading international banks, meets quarterly to discuss issues around various financial crimes that depend on international banking services like money-laundering, corruption, financing of terrorism, and breaching internationally agreed-upon economic sanctions (Aiolfi and Bauer, 2012).

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Coordination is considered difficult in the context of international finance and it is therefore significant that more than a third of the top banks voluntarily joined this particular multi-stakeholder agreement. Bank participation is the outcome of complex causation of organizational, institutional and regulatory factors that cannot satisfactorily be studied using statistical regressions, because the number of cases are too few. For this reason Maggetti (2014) brought set-theoretic methods to bear on the problem of identifying the configuration of causal conditions for participation by top banks in such a multi-stakeholder agreement. He employed fuzzy set Qualitative Comparative Analysis (fsQCA) to investigate seven factors drawn from firm level, institutional context, and the regulatory framework. Each of these factors were backed up by a hypothesis derived from organizational and institutional theory.

Qualitative Comparative Analysis was specifically developed by Ragin (2008) in the context of comparative politics and thus originally intended for comparative case studies with relatively few cases. Since Ragin developed fuzzy set QCA (fsQCA) the fields of application diversified. QCA and fsQCA are focused on including cases in sets of conditions and then making complex causal or descriptive inferences based on necessary and sufficient conditions. It takes a causes of effects approach that seek to explain why particular cases have certain outcomes by coming up with various configurational recipes of causes which can be stated in a robust way and then logically minimized to parsimonious solutions. It is attractive for social scientists because it allows for complex causation and equifinality. This method is therefore well-suited to studying the organizational, macro-institutional and regulatory factors impacting on bank's participation in multi-stakeholder agreements in combination.

This paper uses Maggetti's input data to replicate his findings, achieved with fsQCA, with a different method, namely Formal Concept Analysis (FCA). The two methods share set-theoretic roots, but whereas QCA was developed for specifically for social research, FCA is a framework for data-analysis that is in principle domain-agnostic. Unlike QCA, FCA lacks an explicit focus on causality and is instead geared towards understanding the structure inherent in the data. However, by means of the notion of intent, FCA can be used to identify the necessary and sufficient conditions for bank participation in the multi-stakeholder agreement.

The next sections first describe Maggetti's dataset, explain how it was constructed in accordance with various choices regarding operationalization of the factors and scaling when coding them. Thereafter we describe the results of the fsQCA analysis and the conclusions reached. Second, the basic FCA definitions are explained, choices about scaling of Maggetti's raw input data for FCA are described along with operations to obtain implications that support or contradict Maggetti's findings.

2 Participation factors studied with fsQCA

2.1 Dataset

The cases in Maggetti’s dataset consist of the 26 banks that were on the list of the top 25 private banking institutions at the time.¹ Ten of the 11 banks that make up the Wolfsberg Group are on this list. The eleventh bank in the Wolfsberg Group, Bank of Tokyo-Mitsubishi UFJ, was left out of on the grounds that it was not among the top 25 banks (Maggetti 2014, p.801). The rest of the cases are the further 16 banks on the top 25 list. Various causal conditions² that could explain participation in the Wolfsberg initiative were hypothesized and then coded for each case. The raw input data for each case and the various conditions and their relation to the output condition of participation are reproduced in Table 1.

Table 1. Input data from Maggetti (2014)

Case	Country	BankType	Owner	Code	CorpC	FinLib	RegInt	BList	Wolfs
ABNAmro	NLD	Universal	Public	No	0.74	0.98	144	Yes	No
Barclays	GBR	Commercial	Public	Explicit	0.14	1	277	Yes	Yes
BNP Paribas	FRA	Universal	Public	Implicit	0.82	1	75	No	No
Carnegie	SWE	Investment	Public	No	0.71	0.95	83	No	No
Citigroup	USA	Commercial	Public	Explicit	0	1	426	Yes	Yes
Coutts & Co	GBR	Private	Public	Implicit	0.14	1	277	Yes	No
CS	CHE	Universal	Public	Explicit	0.44	0.95	83	Yes	Yes
Deutsche Bank	GER	Universal	Public	Explicit	0.95	0.9	45	No	Yes
Goldman Sachs	USA	Investment	Public	Explicit	0	1	426	Yes	Yes
HSBC	GBR	Commercial	Public	Implicit	0.14	1	277	Yes	Yes
ING	NLD	Universal	Public	Implicit	0.74	0.98	144	Yes	No
JPMorgan	USA	Commercial	Public	Explicit	0	1	426	Yes	Yes
Julius Baer	CHE	Private	Public	No	0.44	0.95	83	Yes	No
LCF	FRA	Private	Private	No	0.82	1	75	No	No
LODH	CHE	Private	Private	No	0.44	0.95	83	Yes	No
MeesPierson	NLD	Private	Public	No	0.74	0.98	144	Yes	No
Merrill Lynch	USA	Investment	Public	Implicit	0	1	426	Yes	No
Morgan S	USA	Investment	Public	Explicit	0.14	1	277	Yes	No
Nordea	SWE	Universal	Public	Implicit	0.71	0.95	83	No	No
Pictet & Cie	CHE	Private	Private	No	0.44	0.95	83	Yes	No
RBC	CAN	Universal	Public	Explicit	0.23	1	149	No	No
Rothschild	GBR	Investment	Private	No	0.14	1	277	Yes	No
Santander	ESP	Universal	Public	Explicit	0.77	1	53	No	Yes
SG	FRA	Universal	Public	Explicit	0.82	1	75	No	Yes
UBP	CHE	Private	Private	No	0.44	0.95	83	Yes	No
UBS	CHE	Universal	Public	Explicit	0.44	0.95	83	Yes	Yes

¹ Since two banks were tied, the top 25 list consists of 26 banks in total.

² What is known as “conditions” in QCA, are known as “factors” in other methods.

2.2 Conditions, operationalization and coding

The seven conditions that were hypothesized to influence participation in the agreement are the type of bank, whether it is publicly owned, the existence of an internal code of conduct, the coordination of corporate relationships (an index that integrates shareholder power, dispersion of control, and size of the stock market), the extent of financial liberalization, the stringency of regulations, and whether the target country is on an IMF blacklist. These factors were operationalized and coded by Maggetti as follows.

The type of bank (label: BankType). Maggetti hypothesized that banks focused on investment and private banking would have less incentive to join the agreement. Consequently he coded deposit or commercial banks 1 and investment and private banks 0.

Public ownership (label: Owner). Maggetti assumed that public ownership would increase the likelihood of joining the agreement and if the bank was publicly traded during the decade preceding the agreement it was coded 1 and 0 if it was not.

Internal code of conduct (label: Code). The prior existence of self-imposed codes of conduct against money laundering was considered a driver for joining the agreement. Cases where the internal code of conduct explicitly mentions money laundering were assigned 1, cases where a code of conduct implies money laundering without explicitly mentioning it were assigned 0.5, and cases where such a code was absent were assigned 0.

Coordination of corporate relationships (label: CorpC). Here Maggetti (2014) followed Hall and Gingerich (2009) to create a corporate coordination index that integrates shareholder power, dispersion of control, and the size of the stock market. Maggetti's hypothesis holds that higher coordination of corporate relationships will increase an individual bank's ability to participate in a multistakeholder agreement. Domain expertise was used to code each bank onto a 6-point scale.

Extent of financial liberalization (label: FinLib). In this case, Maggetti relied on the average of a particular indicator regarding financial reform for the years 2000-2005 from database compiled by Abiad, Detragiache, and Tressel (2008). Using a 6 point scale the level of liberalization of the markets each bank operates in was coded with 1 denoting full liberalization. For the sample of banks under investigation only the top half of the scale was present empirically, since all of the banks were either in markets that were fully liberalized, almost fully liberalized, or more liberalized than not. Maggetti hypothesized that liberalization would be positively related to the need for multistakeholder agreements.

Stringency of regulation (label: RegInt). It was assumed that regulatory intensity would lead to compliance with the agreements. Maggetti used a 7-point scale to capture variation on the regulatory intensity in the various markets that the individual banks operate in. The data used to populate this scale came from Jackson's (2007) comparison of the costs of financial regulation per GDP.

Presence on IMF blacklist (label = BList). Maggetti used a 1999 blacklist published by the IMF of money laundering and tax haven countries. He hypothesised that presence on the blacklist exerts normative pressure on banks to participate in multistakeholder agreements and coded presence on the list as 1 and absence as 0.

Participation (label = Wolfs). The outcome condition was coded 1 when a bank participated in the Wolfsberg Initiative against money laundering and 0 if it did not.

2.3 Results of fsQCA

The aim of the analysis was to discover various subset relationships where a condition (or a combination of conditions) are either a subset of the outcome set and thus can be considered sufficient for an outcome, or where the outcome set is a subset of the condition set and thus can be considered necessary conditions for the outcome. This was done by Maggetti in two steps: first, he determined the necessity by identifying all conditions with set membership scores equal or greater than the membership score of the outcome condition; second, he determined sufficiency by comparing membership scores in the outcome condition with scores for all possible combinations of conditions (Maggetti 2014, p. 803). Thereafter he tested for consistency and coverage according to methods proposed by Ragin (2008, chapter 3) and derived complex, intermediate, and parsimonious solutions.

The results of the analysis were that public ownership (consistency 1.00; coverage 0.48) and the prior existence of a code of conduct (consistency 0.95; coverage 0.68) were necessary conditions for participation in the Wolfsberg Initiative (Maggetti 2014, p. 806). The results of the tests for sufficiency for the complex solution (consistency 0.92; coverage 0.48) were that $\text{BankType} \times \text{BList} \times \text{FinLib} \times \text{CorpC}$ are sufficient. In other words a universal, deposit, or commercial bank that were blacklisted and in a fully liberalized context in terms of financial market and the coordination of corporate relations will definitely participate in the Wolfsberg Initiative. The intermediate solution (consistency 0.77; coverage 0.57) holds that $\text{BankType} \times \text{BList} \times \text{FinLib}$ are jointly sufficient; in other words corporate coordination is left out. Finally, the parsimonious solution (consistency 0.75; coverage 0.60) holds that a combination of bank type and the presence on the blacklist are sufficient to explain participation in the Wolfsberg Initiative (Maggetti 2014, p. 807).

3 Results of FCA

Since the dataset used for the fsQCA is in table form, it can be structurally represented as a concept lattice and approached via FCA. Under FCA, the banks that made up the cases in the fsQCA study are properly considered to be ‘objects,’ the factors that made up the conditions in the fsQCA study are considered to be ‘attributes.’ Every formal concept in the lattice has ‘extent,’ which is the

corollary of set membership in fsQCA, but refers to the set of objects that falls under the formal concept, rather than the cases that belong to a particular configuration of conditions. Every formal concept also has ‘intent,’ which is the corollary of necessary and sufficient conditions in fsQCA, and refers to the set of all common attributes of objects from the extent.

3.1 FCA definitions

Let us recall the basic definitions of Formal Concept Analysis (Ganter and Wille, 1999). We consider a set G of objects, a set M of binary attributes and a binary relation $I \subseteq G \times M$ such that $(g, m) \in I$ if object g has the attribute m . Such a triple $K = (G, M, I)$ is called a *formal context*. Using the *derivation operators*, defined for $A \subseteq G$, $B \subseteq M$ by

$$A' = \{m \in M \mid gIm \text{ for all } g \in A\},$$

$$B' = \{g \in G \mid gIm \text{ for all } m \in B\},$$

we can define a *formal concept* of the context K to be a pair (A, B) satisfying $A \in G$, $B \in M$, $A' = B$, $B' = A$. A is called the *extent*, B is called the *intent* of the concept (A, B) . These concepts, ordered by $(A_1, B_1) \geq (A_2, B_2) \iff A_1 \supseteq A_2$ form a complete lattice, called *the concept lattice* of $K = (G, M, I)$. However, this paper depends more on the following definition of *(attribute) implication*: For $A, B \subseteq M$ the implication $A \rightarrow B$ holds if $A' \subseteq B'$, i.e., all objects having all attributes from A also have all attributes from B .

Using the definition of implication we can model strict dependencies between the values of the target attribute, i.e., statements whether a bank has joined the agreement or not, with the values of other attributes of our dataset.

3.2 Scaling of the dataset

To show these dependencies in our dataset, let us first *scale* the many-valued attributes of the original data, i.e., represent them as binary attributes, to produce the natural scaling in Table 2.

Table 2. Natural scaling

Attribute	Scale	Values
BankType	nominal	universal, commercial, investment, private
Owner	nominal	public, private
Code	nominal	none, at least implicit, explicit
CorpC	ordinal	0.0, 0.14, 0.23, 0.44, 0.71, 0.74, 0.77, 0.82, 0.95
RegInt	ordinal	45, 53, 75, 83, 144, 149, 277, 426
FinLib	ordinal	0.9, 0.95, 0.98, 1.0
BList	nominal	yes, no
Wolfs	nominal	yes, no

We saw bank type as a nominal scale and binarized this attribute by creating a binary attribute for each of the four types of banks present in the raw data, namely universal deposit, commercial, investment, and private banks. Here we diverge from the prior study that coded bank type according to the hypothesis derived from theory, thereby creating two categories that lumped investment banks with private banks and commercial banks with universal deposit banks.

We binarized the three point fuzzy-scale for the prior existence of a code of conduct by making a category for each situation: no code of conduct, a code of conduct that at least implicitly discourages money laundering, and a code of conduct that explicitly mentions money laundering activities.

Whereas Maggetti relied on domain experts to code each bank onto a 6-point fuzzy scale for the coordination of corporate relationships (CorpC), we used the raw values from the corporate coordination index as reported by Maggetti. We treated this as an ordinal scale and used thresholds in our binarization on the actual values of 0.0, 0.14, 0.23, 0.44, 0.71, 0.74, 0.77, 0.82, and 0.95. In other words, all cases would be present at $\text{CorpC} \geq 0$, and the number of cases would fall with each threshold of actual values of cases in the index until only six cases remain at $\text{CorpC} \geq 0.82$ and only one at $\text{CorpC} \geq 0.95$.

We treated the data for regulatory intensity (RegInt) in a similar fashion, by using the actual input data of the costs of financial regulation per GDP to binarize using threshold values (at 45, 53, 75, 83, 144, 149, 277, and 426) to create an ordinal scale, rather than relying on the 7 point scale that Maggetti derived from that data. In other words, all cases were present at $\text{RegInt} \geq 45$ and only 4 cases remain at $\text{RegInt} \geq 426$.

For the extent of financial liberalization (FinLib) we relied on Maggetti's fuzzy set for the values and scaled it similarly with thresholds on the values assigned of 0.9, 0.95, 0.98, and 1.0, so that all cases are present at $\text{FinLib} \geq 0.9$ and 14 cases remain at $\text{FinLib} \geq 1.0$.

3.3 Implications derived

In this short paper, we just wanted to replicate Maggetti's results using FCA instead of fsQCA. For this reason we focused on deriving attribute implications related to the outcome condition (namely participation in Wolfsberg Initiative). Using the natural scaling above, we could derive the following implications by navigating the resultant lattice:³

1. All commercial banks participated in the Wolfsberg Initiative. Formally, $\text{BankType: Commercial} \rightarrow \text{Wolfsberg: Yes}$.
2. If the bank owner is private, then the bank does *not* participate in the Wolfsberg Initiative. Formally, $\text{Owner: Private} \rightarrow \text{Wolfsberg: No}$.
3. The absence of a prior code of conduct implies nonparticipation in the Wolfsberg Initiative. Formally, $\text{Code: No} \rightarrow \text{Wolfsberg: No}$. This negative implication is not mentioned by Maggetti, he just claims that the condition

³ This was done using FCART (Neznanov et al. 2013).

(attribute) can determine participation, but in fact attribute *value* is more accurate to determine the sufficient condition (implication).

Although we set out to merely replicate the findings about necessary and sufficient conditions arrived at by Maggetti using fsQCA, we derived some implications that replicate his findings, uncovered some implications not mentioned by him, and found a minor point of disagreement. Deriving the attribute implications by way of FCA show that Maggetti's solution that public ownership and the prior existence of a code of conduct are necessary conditions (Maggetti 2014, p. 806) and a combination of banktype and the presence on the blacklist are sufficient conditions to explain participation in the Wolfsberg Initiative (Maggetti 2014, p. 807) is not as nuanced as it could be.

4 Conclusion

In this short article we have considered a well-known dataset on banks from Maggetti (2014) and proposed to analyze it from the perspective of Formal Concept Analysis (FCA). From the results of the analysis it is clear that FCA presents a simple and transparent way of treating this example. The FCA analysis allowed us to obtain more fine-grained observations than proposed in Maggetti (2014) and helped us to see some flaws in the conclusions reached by the fsQCA method that he used. We would like to focus our future research on considering interesting association rules that can be obtained from the mentioned dataset with the help of pattern structures on numerical and ordinal attributes (Kuznetsov 2009; Kaytoue et al. 2011).

References

- Abiad, A., Detragiache, E., Tresselt, T.: A New Database of Financial Reforms (Working Paper No. 08/266). Washington, DC: International Monetary Fund (2008)
- Aiolfi, G., Bauer, H-P.: The Wolfsberg Group. M.Pieth (ed.) Collective Action: Innovative Strategies to Prevent Corruption. Zurich/St. Gallen: Dike Verlag (2012)
- Ganter, B., Wille, R.: Formal Concept Analysis: Mathematical Foundations. Springer (1999)
- Hall, P., Gingerich, D.: Varieties of Capitalism and Institutional Complementarities in the Political Economy: An Empirical Analysis. British Journal of Political Science, 39, 449-482 (2009)
- Jackson, H.: Variation in the Intensity of Financial Regulation: Preliminary Evidence and Potential Implications. Yale Journal on Regulation, 24(1), 101-139 (2007)
- Kaytoue, M., Kuznetsov, S.O., Napoli, A., Duplessis, S.: Mining Gene Expression Data with Pattern Structures in Formal Concept Analysis. Information Sciences, Volume 181, Issue 10, 1989-2001 (2011)
- Kuznetsov, S.O.: Pattern Structures for Analyzing Complex Data. In: H.Sakai et al., Eds., Proc. 12th International Conference on Rough Sets, Fuzzy Sets, Data Mining and Granular Computing (RSFDGrC 2009), Lecture Notes in Artificial Intelligence (Springer), Vol. 5908, pp. 33-44, 2009

- Maggetti, M.: Promoting Corporate Responsibility in Private Banking: Necessary and Sufficient Conditions for Joining the Wolfsberg Initiative against Money Laundering. *Business & Society*. 53(6), 787–819 (2014)
- Neznanov A., Ilvovsky D., Kuznetsov S.O.: FCART: A New FCA-based System for Data Analysis and Knowledge Discovery. Contributions to the 11th International Conference on Formal Concept Analysis. Dresden : Qucoza, 31-44 (2013)
- Ragin, Charles C.: Redesigning Social Inquiry: Fuzzy Sets and Beyond. Chicago, IL: Chicago University Press (2008)