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How to measure banking regulation and supervision

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ABSTRACT

This paper uses data from 141 countries to identify the variables that best characterize worldwide banking regulation and supervision practices. We apply a nonlinear principal components analysis with optimal variable transformation to deal with the variables' mixed measurement levels and reduce data dimensionality. The robustness of the results is tested for different subsamples. The findings indicate that deposit insurance, liquidity, diversification requirements, complementary banking activities, and market discipline are the most reliable indicators to measure regulation. In contrast, resolution activities, the mandate of the head of the supervisory agency, and the report of prudential regulation infractions assume the same role for banking supervision. Capital requirements and ownership are of minor relevance and are sensitive to a country's development level. China and Germany display the most distinct regulation practices, while China and the UK adopt the most stringent policies regarding supervision.

1. Introduction

Since the 1970s, several systemic banking crises have been registered worldwide (Laeven and Valencia, 2020). The primary reasons for such crises may be diverse, ranging from a bank's specific characteristics (e.g., high leverage, low dimension, and low solvency) (Cebenoian and Strahan, 2004; Inderst and Muller, 2008; Berger and Bouwman, 2013) to country's economic context (e.g., economic depression, sharp credit expansion, high-interest rates, high inflation, and low development) (Demirgüç-Kunt and Detragiache, 2000; Bordo et al., 2001; Hoggarth et al., 2005; Klomp, 2010); however, most explanations indicate the weakness of banking regulation and supervision (RS) frameworks. One of the most evident examples of banking RS failures was the 2007 global banking crisis, which led regulators to review liquidity requirements and capital adequacy with Basel core principles (Muñoz, 2021; Moosa, 2010). This crisis stressed the weakness of market discipline (Swamy, 2018) and triggered a renovated debate on the role of RS as promoters of bank development, performance, and stability (Barth et al., 2013a).

The extant economics literature has thoroughly analyzed the banking RS, primarily focusing on collecting and comparing countries' practices (Barth et al., 2006, 2008; Cihak et al., 2012; Anginer et al., 2019), assessing its compliance with given quality standards (Neyapti and Dincer, 2005; Cihák and Tieman, 2008), and highlighting Basel core principles (Aiyar et al., 2015; Jacques, 2017). Wall and Peterson (1996) emphasized capital regulation structure, banks' responses to different capital regulation types, and costs and benefits of capital adequacy as core concerns toward banking regulation. Eichengreen and Dincer (2011) and Barth et al. (2013a)

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showed that supervisory independence from politicians and banking firms increases supervision efficiency and improves banks' performance, while Beck and Wagner (2016) stressed the importance of supranational supervision of banks in currency unions. Neyapti and Dincer (2014) identified RS (in general) as a source of several positive effects on banking activity, including its ability to enhance banking performance by improving depositors' trust and borrowers' discipline. Yang et al. (2019) showed that tighter RS is positively related to efficiency for Asia-Pacific commercial banks, while Barth et al. (2013a) concluded the opposite for developed and developing countries. As discussed by Lopes (2018), the literature on the relationship between banking crises and regulation is inconclusive, forming a duality, with some researchers believing that crises result from excessive regulation and others assuming deregulation is the trigger for those events. Nonetheless, both visions agree that RS frameworks must be reviewed.

At an institutional level, some efforts have been made to provide a big picture of banking RS worldwide. Two of the most complete studies are the International Monetary Fund (IMF) and World Bank inventories and assessments of countries' RS practices: the Financial Sector Assessment Program (FSAP) and the Bank Regulation and Supervision Survey (BRSS). The IMF and World Bank have jointly applied the FSAP and, to date, have analyzed the financial stability and development of more than 75% of the institutions' member countries.¹ The BRSS, conducted by the World Bank and answered by each country's official regulatory and supervisory authorities, has been collecting comparable data across the participant countries since 1997, providing comprehensive information on RS practices for more than 100 central banks worldwide. However, scientific papers have not fully exploited this information, probably due to its extent (the survey includes hundreds of questions) and complexity. Most papers using BRSS data are limited to one or two survey answers as a proxy for banking RS. Others compare responses from the different versions of the survey to assess banking RS evolution or efficiency, construct some partial indices related to specific domains of RS, or find differences between regulatory and supervisory practices of countries with and without banking crises (Barth et al., 2004, 2013a, 2006, 2008; Pereira Pedro et al., 2018; Swamy, 2018; Anginer et al., 2019; Yang et al., 2019). While these studies allow a better understanding of RS progression and its adjustments to systemic events (such as banking crises), the use of partial information (e.g., indices for some RS dimensions only or the use of single variables related to capital requirements, deposit insurance, or market discipline) leads to a fragmented and limited vision of the phenomenon.

The much-needed revision of the RS frameworks suggested by the literature is impossible without a comprehensive understanding of all their characteristics, which, given the enormous amount of information available, requires accurate identification of the most appropriate variables to measure and summarize such banking dimensions. This paper aims to summarize the vast range of information provided by the BRSS using proper statistical methods to identify variables characterizing RS practices worldwide. The study begins with an extensive analysis of the BRSS, considering all the available quantitative and qualitative information across at least four BRSS editions. This information is then normalized and modeled using a nonlinear principal components analysis based on the Meulman (1992) optimal scaling approach. A total of 119 RS worldwide practices are scrutinized for 141 countries on 5 continents, including offshore jurisdictions. This study then compares countries with different development levels and observes asymmetries among offshore and non-offshore countries. We also contribute to the identification of clusters of countries adopting similar RS frameworks out of total observed practices and to the detection of extreme outliers in the global RS context.

This paper is organized into five sections, including this introduction. Section 2 reviews the main methods used to assess RS practices, while Section 3 describes the BRSS data considered in the paper to evaluate such practices and presents the methodological options. Section 4 describes and discusses the results, and Section 5 presents the concluding remarks.

2. Assessing regulation and supervision practices

This paper separately examines RS practices. Many past studies have considered RS as a single subject; therefore, in the following literature review, some of the findings and methods discussed in the sub-section dedicated to regulation (supervision) also apply to supervision (regulation).

2.1. Assessing regulation

Research studies have evaluated regulation from three main perspectives: the evaluation of the quality of countries' regulatory systems, the theoretical study of specific regulation practices, and the collection, analysis, and comparison of countries' regulatory practices.

The analysis of the quality of regulatory frameworks gained visibility with recent works for transition economies (Neyapti and Dincer, 2005) and 120 IMF countries (Cihák and Tieman, 2008). Neyapti and Dincer (2005) used Basel guidelines and the letter of banking laws as a reference, establishing 98 evaluation criteria grouped into eight categories² to assess the quality of the legal environment regarding RS in each sample country. They used a simple codification method, ranking the criteria from 0 to 1³ and calculating unweighted averages for each category and the complete data, resulting in an aggregated index to measure RS. Furthermore, the authors applied principal components analysis, reducing the 98 criteria to only 3 or 4 components depending on the specific

¹ For further information related to this assessment, see <https://www.imf.org/external/np/fsap/fsap.aspx> and <https://www.imf.org/external/standards/index.htm>.

² Capital requirements, lending, ownership structure, directors and managers, reporting/recording requirements, corrective action, supervision, and deposit insurance.

³ Where 1 indicates the best quality. Normalized codes were obtained by rescaling processes. See Neyapti and Dincer (2005) for full details.

method used. Such components included a wide range of the initial criteria and showed that rule-based banking laws enhance regulatory transparency and make bank operations easier to monitor.

In contrast, Cihak and Tieman (2008) considered the whole financial sector, including the banking sector, insurance, and securities. They used the FSAP (which assesses the compliance of each country with international codes according to IMF and World Bank experts) as the basis for evaluating the quality of countries' financial sectors by grading the observance of each principle (previously rated in a 4-notch scale) in a 0–100 scale. They found substantial differences across countries' RS frameworks, which were explained by differences in their economic development level, with high-income countries displaying higher compliance scores. Despite their relevant findings, the authors recognize that a higher level of compliance does not necessarily imply a better RS system and that assessors' experience and expertise may bias grading assessments. These limitations follow Neyapti and Dincer's (2005) acknowledgment that a higher compliance level does not necessarily indicate higher regulatory strictness.

Regarding studies that analyze single regulation practices, the most frequent approaches to evaluate regulation frameworks considered minimum capital ratios, capital requirements/accordance with Basel core principles, depositor's protection schemes (or deposit insurance), and market discipline, among other topics. However, as discussed next (Demirgüç-Kunt and Huizinga, 2004; Fullenkamp and Rochon, 2017), analyzing a particular regulation practice does not seem sufficient to determine the efficiency and quality of the whole country's regulatory framework.

Capital requirements, or minimum capital ratios, imply that banks under the same regulatory standards (such as Basel I and its goals) should present similar capital levels. Therefore, capital ratios are often used as the main feature of banking regulation (Aiyar et al., 2015; Fullenkamp and Rochon, 2017; Shaddady and Moore, 2019; Ambrocio et al., 2020) and to evaluate countries' exposure to financial institutions' distress (Wall and Peterson, 1996), and analyze the impact of capital regulation on bank risk (Ashraf et al., 2020; Mateev et al., 2022). Nonetheless, according to Jacques (2017), even in the presence of uniform risk-based capital requirements, banks may not present similar capital ratios. Indeed, risk weights and risky asset selections set by countries and not by Basel Accords may result in higher or lower real capital ratios depending on each country's arbitrage.

Deposit insurance schemes aim to lower the risk of systemic crises, and since the subprime crisis, they have naturally gained popularity (Cihak et al., 2012), and their existence is often seen as a sign of regulation strength, given their expected effects in stabilizing the payment and financial systems (Cull et al., 2002). Nevertheless, a contradictory impact has also been observed in systemic stability: in the presence of a weak regulatory environment and an unstable banking sector, explicit deposit insurance may lead to downturns in the economy's financial depth.⁴ Accordingly, Demirgüç-Kunt and Kane (2002) referred to explicit deposit insurance schemes as a potential source of future banking crises. Moreover, Aiyar et al. (2015) argued that the presence of safety nets, such as deposit insurance schemes, incentivizes banks to take excessive risk by keeping their capital at the minimum required level.

Market discipline is often assumed to boost bank efficiency (Yang et al., 2019); however, evaluating market discipline levels is not enough to assess the quality of regulation practices. As Lane (1993) suggested, quality assessment requires analyzing the quality of the disclosed information, the degree of independence and openness of financial markets, and the quality of market monitorization. Furthermore, Uchida and Satake (2009) considered the numbers of depositors and market investors, postulating that banks presenting significant deposits are more efficient regarding market discipline mechanisms, and investors have a disciplinary role in bank management.

Finally, regarding data collection on banks' regulatory practices, its analysis, and comparison, the most comprehensive studies are those of Barth et al. (2004, 2006, 2008), Cihak et al. (2012), and Anginer et al. (2019), who report and analyze the results of the five systematic, cross-country BRSS sponsored by the World Bank. Barth et al. (2004, 2006); and (2008) concluded that, even after the strengthening of RS, expected to be induced by the Basel II guidelines, this would be insufficient to improve banks' stability and efficiency. Concerning the latest update of BRSS2011, Cihak et al. (2012) confirmed such conjectures, concluding that the global regulatory response to the crisis had been slow and left room for enhancements. Anginer et al. (2019) analyzed the most recent BRSS, focusing on the evolution of regulatory and supervision practices since the subprime crisis. They found that supervision and regulation became stricter and more complex after the crisis, determining that even in the presence of higher regulatory capital, market discipline appears to have worsened due to the adoption of more generous safety nets in the post-crisis years. Other studies using BRSS as a data source include Swamy (2018), who compared subprime crisis and non-crisis countries, and Barth et al. (2013b), who transformed several survey answers into composite variables to measure bank activity, financial conglomerates, competition regulation, capital, deposit insurance schemes, market structure, and external governance.

2.2. Measuring supervision

Previous literature addressing banking supervision may also be reviewed under the perspectives for regulation. Concerning the quality of supervision, all studies previously cited considered regulation and supervision as a single activity, including Neyapti and Dincer (2005), who identified the report of banking risks (identified during supervisory actions) as a synonym of RS quality.

The primary studies that strictly focus on supervision practices include Beck and Wagner (2016), who studied supranational supervision in currency unions, and Eichengreen and Dincer (2011), who compared supervisory responsibility appointed to central banks versus other supervisory authorities. Beck and Wagner (2016) argued that, due to a lower heterogeneity across countries sharing the same currency, supranational supervision ensures sounder safety than national supervision. They also state that two of the best

⁴ The World Bank states that *financial depth* "captures the financial sector relative to the economy. It is the size of banks, other financial institutions, and financial markets in a country, taken together and compared to a measure of economic output."

Table 1
Bank Regulation and Supervision Survey (BRSS) editions and details.

Survey	Data collection	N.° of countries	Current version (latest release)	Related paper/book
BRSS2001	1997–1999	118	Final (January 2005)	Barth et al. (2006)
BRSS2003	2001	151	Final (March 2004)	Barth et al., (2004, 2006)
BRSS2007	2005–2006	142	Final (June 2008)	Barth et al. (2008)
BRSS2011	2008–2010	142	Final (September 2012)	Cihak et al. (2012)
BRSS2019	2011–2016	159	Preliminary (October 2019)	Anginer et al. (2019)

Source: Authors' research.

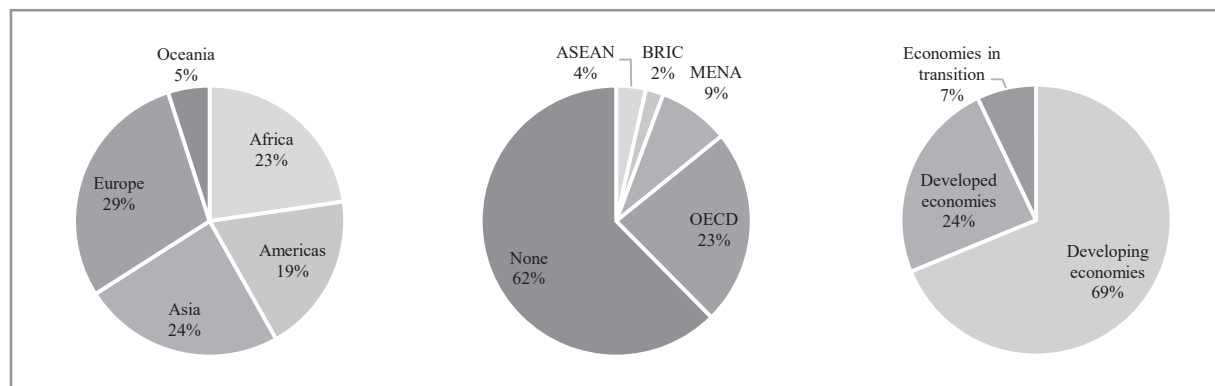


Fig. 1. Sample description, by continental regions, political and economic alliances, and country development, level. Source: Authors' calculations. The political and economic alliances mentioned in Fig. 1 are: Association of Southeast Asian Nations, (ASEAN); Brazil, Russia, and China (BRIC); Middle East and North Africa (MENA) and Organization for, Economic Co-operation and Development (OECD).

examples of this practice are the Eurozone Single Supervisory Mechanism, which has a supranational supervisor and an organized resolution system for its partial banking union, and the Community of African Banking Supervisors, a subsidiary body of the Association of the African Central Banks, which represents Africa's first steps on the way to closer cooperation between banks. Regarding the supervisory responsibility, the existence of specific supervisory authorities outside the central bank's control seems to result in fewer non-performing loans and, consequently, the request for less capital against assets (Eichengreen and Dincer, 2011).

Lastly, surveying initiatives applied to central banks and other supervisory agencies (such as the BRSS) typically include a detailed section for supervision. BRSS data has been used to construct proxies for supervision effectiveness, such as the *official supervisory power* (Barth et al., 2013a) and the *strength of external audit* (Barth et al., 2006) indicators. The authors found a positive relationship between supervisory power and bank efficiency in both cases. Barth et al. (2013b) also developed partial indices for measuring particular aspects of supervision, such as official supervisory action variables, official supervisory structural variables, and private monitoring variables. More recently, Pereira Pedro et al. (2018) used the BRSS to construct country indicators for measuring the strength of banking regulation and supervision practices; however, their indicators were based only on a few survey questions, corresponded to a simple counting of expected answers, and were used in a context where banking RS was not the focus.

3. Sample and methodology

3.1. Data

RS topics remain on central banks' and scientific research agendas, with increasing studies focusing on banking RS in recent years, particularly after 2011. Lopes (2018) concluded that the 2007 crisis conducted significant literature adjustments on RS issues; however, literature on RS evaluation in a broad scope (of countries and practices) is relatively scarce.

This study uses data from the BRSS, which covers a wide range of practices and countries, to address this research gap and obtain an extensive perspective of the RS international scenario. Table 1 shows that five editions of the BRSS are available, the last of which is still preliminary. These editions cover a significant variety of RS practices, which were initially (until the 2007 version) grouped into 12 topics: *entry into banking*; *ownership*; *capital*; *activities*; *external auditing requirements*; *internal management requirements (bank governance in the 2019 version)*; *liquidity and diversification requirements*; *depositors' (savings) protection schemes*; *provision requirements (including asset classification and write-offs in the 2019 edition)*; *information disclosure*; *discipline/problem institution/exit*; and *supervision*. The 2011 edition added *banking sector characteristics* (13) and *consumer protection* (14), and the 2019 edition added (15) *Islamic Banks*.

Not all questions of each version are available in all BRSS editions. We allow comparisons over time by considering only questions that, in addition to displaying nonzero variance across countries, are common to at least four out of the five survey editions. The 2012 version of the BRSS 2011 was used as the data source to illustrate the application of our methodology to summarize the available information; however, the proposed approach may be easily applied to any other BRSS edition, including the 2019 version, as soon as

its final version becomes available.

In this approach, regulation practices include those connected to the entry into banking activity, rules toward banking capital and complementary authorized activities (security market, insurance, or real estate), guidelines to external auditing, and bank governance. Regulation practices also comprise asset diversification, deposit insurance schemes, asset classification, the report of the quality of the loans, and the application of international accounting standards. Regarding supervision practices, we consider questions related to audit findings and reports, the relationship between the banking supervisor and the external auditor, public disclosure standards, and enforcement powers of the supervisory agency. The institutional structure and mandate of the supervisory authority, practices concerning the supervisory approach and the supervisory staff characteristics, and the definition of powers to perform resolution activities are also within the supervisory practices analyzed in this study. Please see the [supplementary material](#) for more information on RS practices and their clear identification.

Table 1 shows that BRSS 2011 comprises information from a sample of 142 countries⁵ (listed in Table A1 in Appendix A), covering many different geographical and political regions with different development levels. In particular, Fig. 1 shows that the sample in our study includes countries from Europe (41), Asia (34), Africa (32), America (27), and Oceania (7). The sample includes 33 of the 37 current members of the Organization for Economic Co-operation and Development (OECD), jointly with 12 of the 19 Middle East and North Africa (MENA) countries, and 5 of 10 members of the Association of Southeast Asian Nations (ASEAN). Three of the four BRIC (Brazil, Russia, and China) countries are also included in the sample. Most nations (88) in the sample do not belong to any major political or economic alliance. Regarding development levels, following the United Nations country classifications, Fig. 1 also shows that developed economies (34 countries) represent 24% of the sample and economies in transition (10 countries) 7%; most survey respondents are developing countries (97 countries).

3.2. Variable construction

The selected survey questions were used to construct 82 variables related to regulation and 35 to supervision. These include 31 quantitative and 50 qualitative (28 binary and 22 categorical with more than two options) variables that measure different aspects of regulation and 12 quantitative and 23 qualitative (12 binary and 11 with more than two categories) variables measuring supervision practices.

To construct those variables, we analyzed each question and decided how to address potential issues, such as aggregation of alternatives, open-ended questions, missing data, and other data concerns. Next, we briefly describe each of the main issues we dealt with and provide some examples of how we addressed those issues in specific questions. We identify each variable using its original BRSS numeration (where, for example, Q.1.3 is the third question of topic 1) to relate our variables to BRSS questions. Furthermore, because questions related to supervision issues are also present in other topics besides the 12th, we added a suffix (*Reg* or *Sup*) to each variable's original code to identify which are related to regulation and which address supervision practices. For example, question Q.1.3. (regarding regulation matters) was coded as Q.1.3_Reg, while variable Q.5.9. on the topic of supervision was coded as Q.5.9_Sup. The entire RS data handling description is available as [supplementary material](#).

3.2.1. Aggregation of alternatives

While some survey questions were quickly transformed into binary or categorical variables, others had to be recoded to obtain comprehensible variables. In particular, BRSS contains questions divided into up to six items, each with *yes* or *no* as possible answers or with the option of being selected or not; we identified all possible combinations of *yes/no* (or *selected/not selected*) answers to a given question, with each possible combination representing a different category for the resulting variable.

One example of this approach is question Q.9.2_Reg:

9.2 - Which criteria are taken into account to classify loans and advances as non-performing?

- a. Significant financial difficulty of the borrower and deterioration in its creditworthiness;
- b. Breach of contract (e.g., default or delinquency in interest or principal payments);
- c. Restructuring (i.e., concession granted, for economic or legal reasons relating to the borrower's financial difficulty, that the lender would not otherwise consider);
- d. Borrower bankruptcy or other financial reorganization;
- e. Days past due status (please specify number of days);
- f. Existence of collateral guarantees and/or other credit mitigants.

Countries could choose all the options, none, or some different combinations (i.e., countries could answer *yes* or *no* to all options; or *yes* to some queries and *no* to others). Thus, 64 possible categories result from the following combinations:

$$\text{Combination of options, } Q\text{-}9\text{-}2\text{-}Reg = {}^6C_6 + {}^6C_5 + {}^6C_4 + {}^6C_3 + {}^6C_2 + {}^6C_1 + {}^6C_0 = 64 \quad (5)$$

where.

⁵ Despite the reference to 143 jurisdictions on the World Bank website, the available Excel files only contain answers for 142 countries. Due to missing data in most variables, we also excluded Kazakhstan from our sample, obtaining a sample of 141 countries.

6C_6 represents choosing the option *all*, so that ${}^6C_6 = 1$ option (*all*);

${}^6C_j, j = 2, \dots, 5$, represents choosing a possible combination of j options simultaneously (within the 6 possible); for example, ${}^6C_4 = 20$ combined options, with one of those options being *Breach of contract + restructuring + borrower bankruptcy + days past due*;

6C_1 represents each one of the six options isolated so that ${}^6C_1 = 6$ individual options (a, b, c, d, or f); and

6C_0 represents choosing the option *none*, so ${}^6C_0 = 1$ option (*none*).

Central banks did not select all available combinations; thus, the number of categories formed (23) is lower than the total number of possible combinations.

3.2.2. Open-ended questions

Open-ended questions also required specific adjustments. Consider questions such as Q.1.1.Reg,

1.1 - *What body/agency grants commercial banking licenses? Please include the name of licensing agency. If more than one, please describe their respective licensing roles.*

Here, each country gave its answer and was grouped into categories defined according to the nature of the information mentioned. For this question, e.g., 10 categories were formed. For example, all answers involving central banks were grouped into the same category (*central bank*); banking agencies and banking and securities commissions were grouped into *banking agency/commission*; financial services authorities, financial and capital market commissions, financial services commissions, and other similar options led to the *financial services authority/commission* category; and superintendency of banks and commission of banks and insurance are under the category *superintendency of banks*.

3.2.3. Missing data

In our sample, missing values represent more than 5% of the observations in some variables. According to Little and Rubin (2002), such observations should not be deleted, as they might represent a particular characteristic of the sample that should be considered.⁶ Using the additional data provided by each country in the notes to the survey allowed us to classify some missing answers into the available categories using cold-deck imputation and understand that some other responses were missing by design (MBD), resulting from a *not applicable* or equivalent situation.⁷ Furthermore, using appropriate statistical methods, we confirmed that the remaining missing values could be considered as *missing completely at random* (MCAR) or *missing at random* (MAR).

We dealt with MBD, MCAR, and MAR similarly. Regarding categorical variables, we added an extra class comprising all countries with missing values. For quantitative variables, we imputed the same value to all countries with missing data.⁸ This approach follows the OECD (2008) methodological options for imputing missing data in constructing composite indicators; thus, we assume that all records with missing values are equivalent to a random subsample of countries to which specific questions do not apply but should be considered in the analysis.

3.2.4. Other data issues

The original data also comprised composite questions (where countries had to attribute different functions to a list of entities or practices) and ambiguous answers (e.g., interval data instead of a specific percentage or value) that required adjustments.

For example, the composite question 11.5 required a list of entities to be selected and associated with several different functions:

11.5 - *Which authority (BS = Bank Supervisor, C = Court, DIA = Deposit Insurance Agency, BR/AMC = Bank Restructuring or Asset Management Agency, OTH = Other - please specify) has the powers to perform the following problem bank resolution activities?*

- a. *Declare insolvency*
- b. *Supersede shareholders' rights*
- c. *Remove and replace bank senior management and directors*
- d. *Appoint and oversee a bank liquidator/receiver*

In this case, we used the question to construct four variables (Q.11.5a.Sup; Q.11.5b.Sup; Q.11.5c.Sup, and Q.11.5e.Sup), with the same categories (all possible combinations of answers) for each, so that each country could be analyzed for its choice on the authority/authorities with powers to perform each bank resolution activity. Categories were formed similarly to Eq. (5) and composed of options, such as *court, bank supervisor + court*, and *court + other*.

Some other methodological options were necessary to solve the ambiguity of countries' answers. For example, consider question Q.8.11.1.Reg:

8.11.1 *As a share of total assets, what is the value of large denominated debt liabilities of banks (e.g., subordinated debt, bonds, etc.) that are definitely not covered by any explicit or implicit savings protection scheme?*

⁶ Conversely, case deletion is a possibility for the remaining situations in which imputation methods are not an option because a specific country is missing for most variables. This was the case of Kazakhstan, whose records were entirely omitted from the sample.

⁷ This type of missing data was mostly due to questions conditional on other variables in the data set (for example, answering "no" to a previous question, so that the following items related to the same subject are not to be answered).

⁸ Due to their high number of missing values, we adopted the conservative methodological option of assuming all quantitative variables as *supplementary*, which means that such variables do not influence the estimation but will be considered in the subsequent analysis.

Italy's answer was "The current percentage of the total deposits of participating commercial banks actually covered by the scheme varies from 50% to 60%." Hence, a mean of 55% was considered as the answer.⁹

3.3. Statistical methodology

Given the quantitative and qualitative nature of the variables constructed from the BRSS, we applied nonlinear principal components analysis (NLPCA) with optimal variable transformation (also known as *optimal scaling*) to summarize RS practices. NLPCA is a helpful statistical method when many variables with a categorical nature inhibit an efficient analysis of the relationships between subjects (countries in this case) and observed variables, promoting a simultaneous quantification of categorical variables and reduction of data dimensionality. Unlike standard principal components analysis (PCA), which assumes a linear relationship between numeric variables, the optimal scaling approach for NLPCA enables variables to be scaled differently so that categorical variables are optimally quantified and nonlinear relationships between all variables can be modeled (Meulman, 1992). The original set of variables is then reduced into a smaller group of uncorrelated components representing most of the information directly conveyed by the initial variables. Finally, the researcher only needs to interpret a small number of components instead of the initial large number of variables.

To the best of our knowledge, this is the first time that NLPCA has been applied to RS variables. Previous research has considered related methods, such as PCA, which Neyapti and Dincer (2005) used to reduce data dimensionality and aggregate RS variables and Barth et al. (2013a) implemented to construct their *official supervisory power* indicator; however, to be able to use PCA, those authors had to interpret their categorical variables as being truly numeric. This assumption makes little sense since, for example, the intervals between categories in variables measured in a rating scale cannot be presumed equal (Linting et al., 2007). For such cases and others that include variables of mixed measurement levels (nominal, ordinal, and numeric), NLPCA seems a more suitable approach, given that it allows the treatment of the full information provided by the BRSS, respecting the nature of the different types of variables. Moreover, NLPCA allows linear and nonlinear correlations between variables, while PCA only detects linear correlations.

We used the *categorical principal components analysis* (CATPCA) script of the SPSS software to apply NLPCA to our data. First, CATPCA converts string variables into positive integers in ascending alphanumeric order; it then minimizes a least-squares loss function that measures the loss of information resulting from the transformation of the original set of variables into a smaller group (the principal components) to obtain the optimal quantification of each category. According to Linting et al. (2007), both steps co-occur and are alternated through an iterative algorithm that converges to the final stationary point of optimal quantification. Unlike the original categorical variables, their numerical quantification has metrical properties, and the variables can be represented as a vector in the space determined for the objects. The vector coordinates are given by the component loadings, *i.e.*, the (Pearson) correlations between the quantified variables and the principal components (weighted sums of the quantified variables); the coordinates of each country in each principal component are called object scores. In addition to this vector model, CATPCA also provides the centroid model, which assigns coordinates to each category, which are then represented in the same space as the countries.¹⁰ Data must be represented in a matrix with dimension $N \times M$ for N objects and M variables, with $M = M_V + M_B$, in which M_V are the variables fitted in the vector model, and M_B are the variables in the centroid model. Therefore, the objective function for CATPCA jointly fits the vector and centroid models. See Appendix B for details.

To assess the internal consistency of the items, we used the *C-alpha coefficient* (Cronbach, 1951), which measures the proportion of the total variability of the sampled individual indicators from its correlation. This coefficient is usually applied with the Kaiser criterion as an extraction method for principal components (PC). According to the Kaiser criterion, the PC to retain are those whose eigenvalues are higher than one. PC presenting eigenvalues of less than one explains fewer portions of the total variance than for the original variables; thus, it should not be retained. The C-alpha coefficient helps in diagnosing such inappropriate cases. The results obtained for CATPCA are standardized, having approximately zero mean and unit standard deviation, allowing comparison across countries in the sample.

Finally, scree plot visual analysis (Cattell, 1966) is a supporting decision method for extracting PC. This analysis is based on graphs that display eigenvalues in decreasing order along PC; it assumes that little information is added by including an additional principal component when eigenvalues drop sharply. Thus, the last significant component to retain is the one before the curve starts to level off, *i.e.*, the exact point where the curve presents an "elbow" shape.

4. Results and discussion

4.1. Regulation

4.1.1. Principal components selection

We applied the Kaiser rule and the scree plot technique to select the PC. In both cases, eigenvalues measure how much variance is accounted for by each dimension. Using the Kaiser criterion (Table 2), it is possible to summarize all the information provided by the 82 variables into 15 orthogonal components, which explain 81.20% of the total variance of the original dataset. All 15 components are

⁹ See Tables S5 and S6 of the supplementary material for further information on methodological options.

¹⁰ While the vector model is based on projection (of objects and variables), the centroid model is based on distances between object points and category points. Unlike other software alternatives, the CATPCA program allows both models (bilinear/vector model and distance/centroid model) to be obtained in the same analysis. For further details, see Meulman et al. (2004).

Table 2

Categorical Principal Components Analysis results: model diagnostics for regulation. Variance accounted for by each principal component and its internal consistency using Kaiser and scree plot criteria.

<i>Model diagnostics</i>						
<i>PC</i>	<i>Kaiser criterion</i>			<i>Scree plot criterion</i>		
	<i>Cronbach's Alpha</i>	<i>Total (eigenvalue)</i>	<i>% of variance</i>	<i>Cronbach's Alpha</i>	<i>Total (eigenvalue)</i>	<i>% of variance</i>
1	0.934	11.884	23.302	0.936	12.164	23.852
2	0.829	5.349	10.488	0.851	6.019	11.802
3	0.766	4.009	7.861	0.764	3.991	7.825
4	0.634	2.641	5.179	0.705	3.238	6.349
5	0.608	2.475	4.852			
6	0.590	2.373	4.653			
7	0.469	1.850	3.627			
8	0.432	1.735	3.402			
9	0.345	1.511	2.964			
10	0.312	1.441	2.826			
11	0.290	1.398	2.740			
12	0.210	1.260	2.471			
13	0.196	1.238	2.427			
14	0.126	1.141	2.236			
15	0.100	1.109	2.174			
Total	0.995^a	41.413	81.202	0.980^a	25.412	49.828

Source: Authors' calculations.

^a Total Cronbach's Alpha is based on the total Eigenvalue.

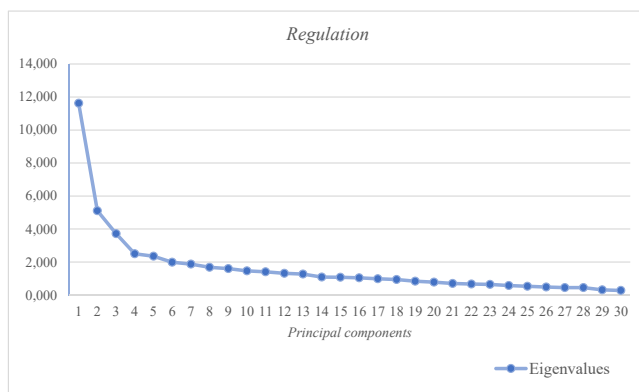


Fig. 2. Scree plot, regulation. Source: Authors' calculations. Scree plot results from Categorical Principal Components Analysis estimates for 82 variables, including 20 dummy variables and 30 categorical variables as analysis variables (corresponds to the number of principal components in the graphic) and the remaining as supplementary variables.

internally consistent, with C-alpha superior to 0. Furthermore, the scree plot analysis (Fig. 2) suggests that data on regulation practices can be grouped into four statistically significant components, which are represented on the left of the downward curve until the inflection point. Table 2 shows that these 4 PC explain around 50% of the total variance, and their eigenvalues are also consistent.

Table A2 (see Appendix A) presents the component loadings (correlations between the quantified variables¹¹ and components), with (absolute) values higher than 0.5 in bold and light shading to highlight which variables determine a principal component. The output resulting from the Kaiser criterion shows a group of 15 variables, all related to deposit insurance questions (variables 8.1 to 8.17.3 and supplementary variable 8.11), that determine PC1. For PC2, the most significant variables are mainly connected to diversification requirements (7.2, 7.2.2, 7.4, and 7.4.1), non-performing loans (NPL), and credit ratings (variables 9.2 and 10.7, respectively), and entry into banking (1.1 and 1.6). For PC3, questions associated with complementary banking activities (4.1, 4.2, and 4.3) are the most important. PC4–PC11 and PC13 are determined by only one variable each, while PC12, PC14, and PC15 are not significantly determined by any variable.

The results for the scree plot criterion confirm most of the conclusions above. All variables determining PC1, PC2, and PC3 in the Kaiser criterion are also relevant in the scree plot version. Furthermore, the latter method shows that banking license practices (entry into banking variables 1.1 and 1.6) also determine PC2. This finding suggests that all the other components are residual in what concerns the identification of the variables that best explain regulation; therefore, as the number of dimensions to keep must be small enough to allow meaningful interpretations, we focus on the four PC components selected by the scree plot version. Table 2 indicates

¹¹ These are the categorical variables quantified after running CAPCA, referred to as “variables” henceforth.

Table 3

Principal Components (PC) composition and labels, regulation. Bold values represent component loadings above 0.5. Variables with higher correlations in each PC determined its label.

Principal component 1 Deposit insurance				
Variables	Component Loadings			
	PC 1	PC 2	PC 3	PC 4
8.1 Is there an explicit deposit insurance protection system for commercial banks?	0.861	-0.061	0.058	-0.007
8.4 Does the deposit insurance agency/fund administrator have the following powers as part of its mandate? c. Bank intervention authority.	0.921	-0.086	0.043	0.074
8.4.1 Does the deposit insurance authority by itself have the legal power to cancel or revoke deposit insurance for any participating bank?	0.921	-0.078	0.058	0.077
8.4.2 Can the deposit insurance agency/fund take legal action for violations against laws, regulations, and bylaws (of the deposit insurance agency) against bank directors or other bank officials?	0.919	-0.068	0.063	0.086
8.4.3 Has the deposit insurance agency/fund ever taken legal action for violations against laws, regulations, and bylaws (of the deposit insurance agency) against bank directors or other bank officials?	0.866	-0.055	0.074	0.095
8.5 Is participation in the deposit insurance system compulsory for the following banking entities?	0.939	-0.089	0.046	0.049
8.6 Are the following types of deposits excluded from deposit insurance coverage?	0.940	-0.070	0.069	0.107
8.7 The deposit insurance coverage type is: a. Per depositor account; b. Per depositor; c. Per depositor per institution; d. Other (please explain).	0.937	-0.076	0.025	0.102
8.10 Is there formal coinsurance, i.e. are ALL depositors explicitly insured for less than 100% of their deposits?	0.907	-0.083	0.022	-0.031
8.11 What percentage of the total deposits of participating commercial banks was actually covered by the scheme as of end of 2010?	-0.603	-0.009	-0.133	0.039
8.12 Is there an ex ante fund/reserve to cover deposit insurance claims in the event of the failure of a member bank?	0.906	-0.051	0.018	0.051
8.13 Funding is provided by: a. Government; b. Banks; c. Combination/Other (please explain).	0.895	-0.081	0.009	0.043
8.14 Do deposit insurance fees/premiums charged to banks vary based on some assessment of risk?	0.927	-0.085	0.021	0.043
8.17.2 Were insured depositors wholly compensated (to the extent of legal protection) the last time a bank failed?	0.672	-0.048	-0.042	-0.004
8.17.3 Were any deposits not explicitly covered by the deposit insurance scheme at the time of failure compensated the last time a bank failed (excluding funds later paid out in liquidation procedures)?	0.706	-0.069	-0.016	0.177
Principal component 2 Requirements on banking licensing, liquidity diversification, and credit				
Variables	Component Loadings			
	PC 1	PC 2	PC 3	PC 4
1.1 What body/agency grants commercial banking licenses? Please include the name of licensing agency. If more than one, please describe their respective licensing roles.	-0.080	0.556	-0.021	0.012
1.4.2 Are the sources of funds to be used as capital verified by the regulatory/supervisory authorities?	0.225	0.684	-0.108	-0.040
1.6 Which of the following are legally required to be submitted before issuance of the banking license?	0.115	0.718	-0.092	0.012
7.2 Are there any regulatory rules or supervisory guidelines regarding asset diversification?	0.233	0.910	-0.119	0.032
7.2.2 Are banks prohibited from making loans abroad?	0.239	0.910	-0.122	0.027
7.4 Are the following requirements in place in your jurisdiction? b. Central Bank reserve and/or deposit requirements.	0.070	0.678	-0.128	0.066
7.4.1 Are banks required to hold reserves in foreign currencies or other foreign-denominated instruments in order to fulfill the requirements listed above?	0.046	0.678	-0.156	-0.098
9.2 Which criteria are taken into account to classify loans and advances as non-performing ...?:	0.240	0.922	-0.170	-0.036
10.7 Are commercial banks required by supervisors to have external credit ratings?	0.143	0.771	-0.150	-0.198
Principal component 3 Capital ownership and complementary banking activities				
Variables	Component Loadings			
	PC 1	PC 2	PC 3	PC 4
2.5.1 Can related parties own capital in a bank?	-0.106	0.104	0.766	-0.015
4.1 What are the conditions under which banks can engage in securities activities?	-0.057	0.132	0.952	-0.090
4.2 What are the conditions under which banks can engage in insurance activities?	-0.099	0.134	0.943	-0.074
4.3 What are the conditions under which banks can engage in real estate activities?	-0.100	0.129	0.943	-0.073
Principal component 4 Entry into banking denied applications and information disclosure				
Variables	Component Loadings			
	PC 1	PC 2	PC 3	PC 4
1.13 What were the primary reasons for denial of the applications in questions 1.7, 1.10, 1.11 and 1.12?	-0.196	0.076	0.019	0.619
10.5.1 Do banks disclose to the public ...? b. Off-balance sheet items; c. Governance and risk management framework	0.269	-0.146	-0.064	-0.634

Source: Authors' calculations.

that these 4 components can explain 49.83% of the total variance. For nonlinear PCA, scree plot results seem to be generally preferred to those produced by other criteria since they are based on the eigenvalues of the correlation matrix of the quantified variables, resulting in a clear interpretation of the plot (Fabrigar et al., 1999; Linting et al., 2007).

4.1.2. The most relevant aspects of regulation

By using the component loadings results for the scree plot scenario, i.e., reducing the original set of variables into four components, we can identify the key variables that best characterize regulation in the current global framework and label each dimension according to the specific information it comprises.

PC1 is entirely composed of BRSS part 8 questions related to depositor (savings) protection schemes and, therefore, is labeled as *deposit insurance*. PC2 is defined mainly by *requirements on banking licensing, asset diversification, and credit*, while PC3 comprises the variables related to *capital ownership and complementary banking activities*. For PC 4, only two contributions are connected with *entry into*

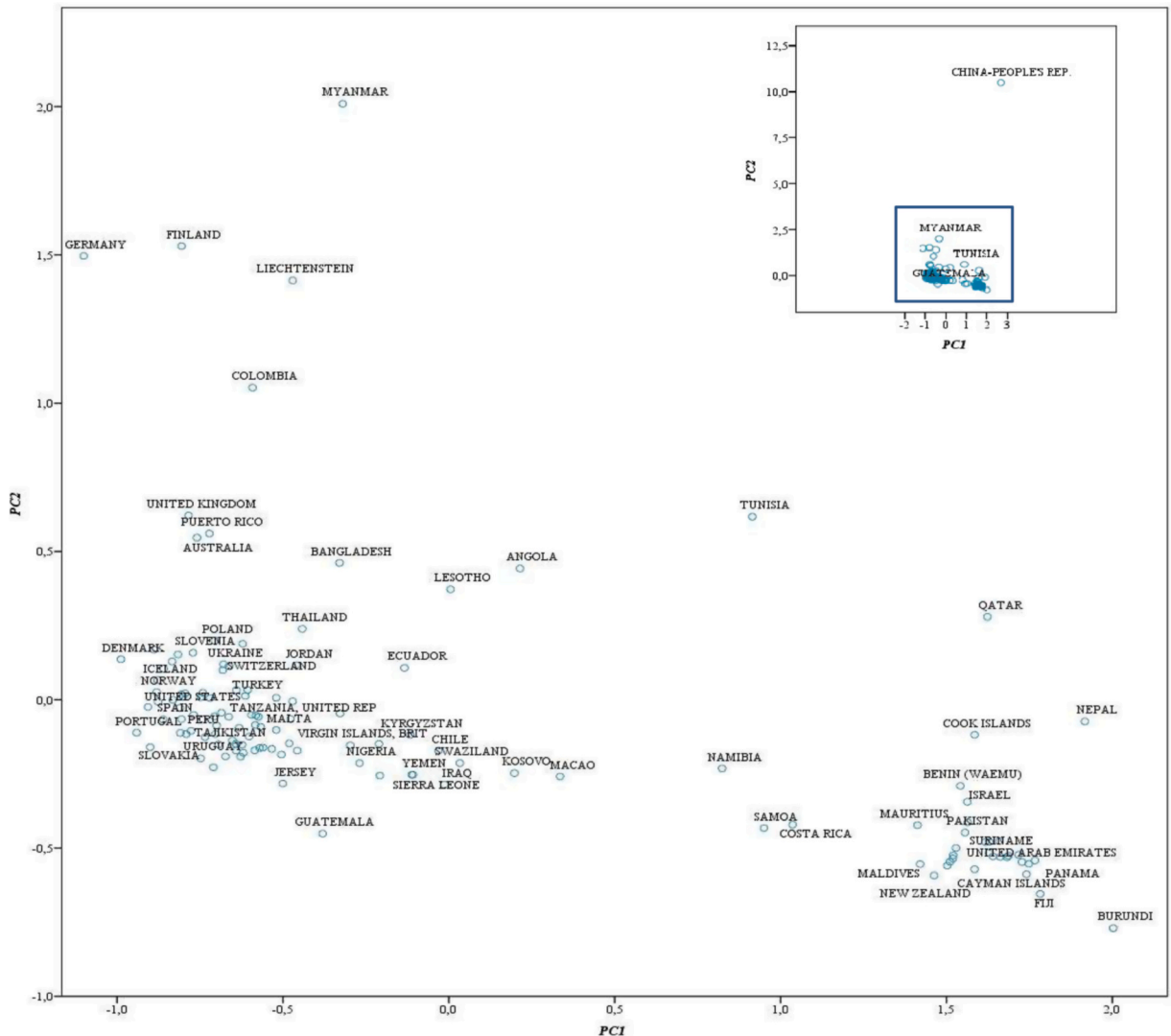


Fig. 3. Object points labeled by country, regulation. Source: Authors' calculations. Country scores from *Categorical Principal Components Analysis* on 82 variables, (30 as analysis variables and 52 supplementary variables). The points in the object scores.plot represent de coordinates of each country in each principal component with, approximately, zero mean and unit standard deviation..

banking denied applications and information disclosure.¹² Table 3 presents a summary of the variables' aggregation in the extracted components and each component label.

The topics covered by each principal component (especially those accounting for the highest loadings in each component) highlight the banking regulatory practices that best describe the global regulatory framework. This means that issues such as deposit insurance, liquidity and diversification requirements, complementary banking activities, market discipline, and (with less expression) capital represent the most relevant proxy candidates to measure banking regulation. These conclusions align with previous research, which frequently emphasizes market discipline (Lane, 1993; Barth et al., 2004; Uchida and Satake, 2009; Swamy, 2018; Anginer et al., 2019), deposit insurance (Cull et al., 2002; Demirgüç-Kunt and Kane, 2002; Cihak et al., 2012), and capital requirements (Moosa, 2010; Aiyar et al., 2015; Jacques, 2017) as the main concerns of regulation.

4.1.3. Country clusters

In addition to the previous findings, CATPCA results also highlight differences across countries, allowing (informal) cluster formation based on the country scores estimated for each PC. Such features may be observed in the plot¹³ of object scores (Fig. 3),

¹² Information disclosure practices are often referred to as market discipline in financial literature.

¹³ Note that, due to the higher number of variables considered in this study, we decided (to simplify the observation of the results) to display all the plots containing only the solution for the most relevant variables.

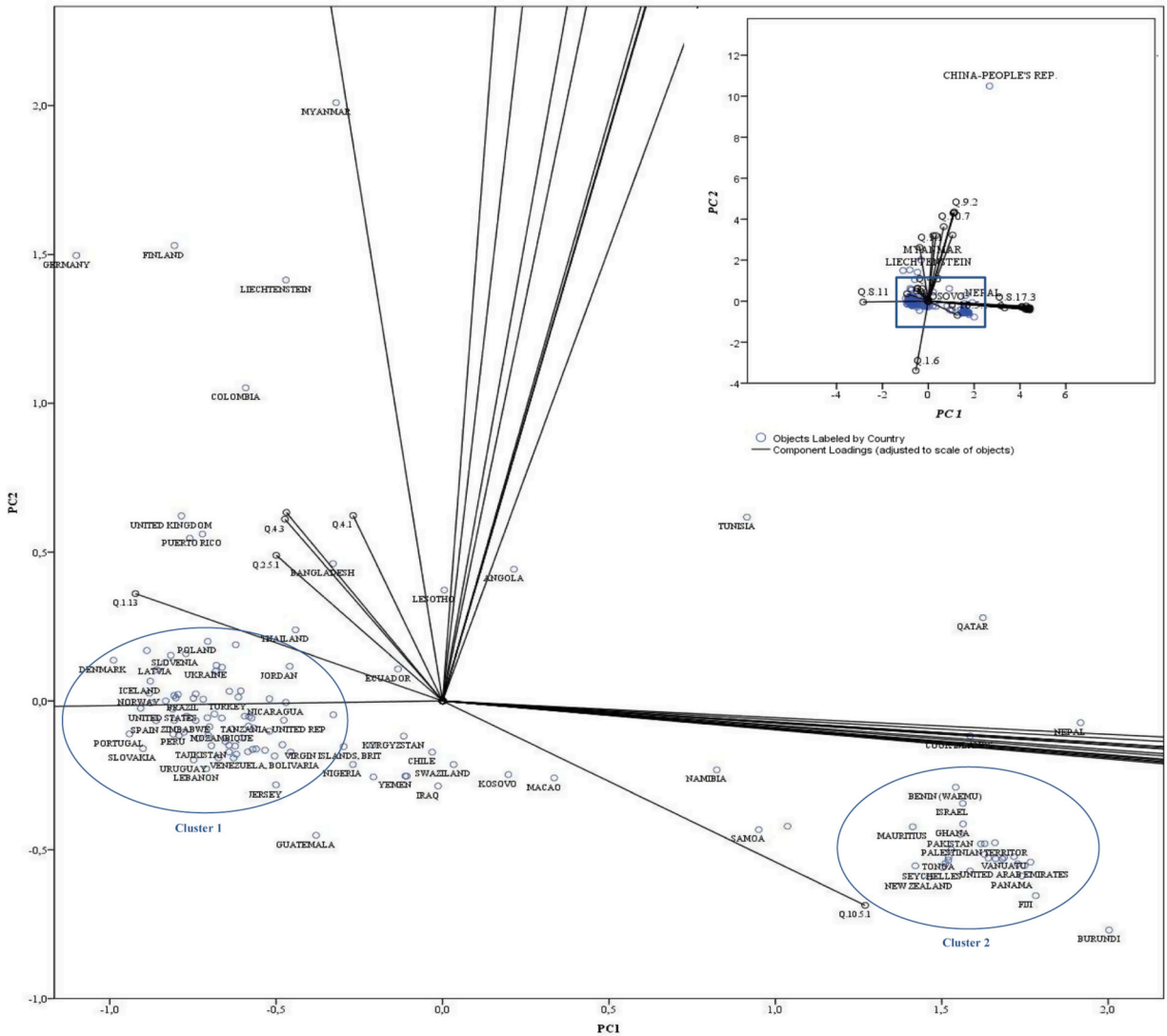


Fig. 4. Biplot of objects and component loadings, regulation. Variable principal normalization. Source: Authors' calculations. Plot of country scores (the points) and component loadings (the vectors) from *Categorical Principal Components Analysis* on the relevant variables to determine regulation. The points are the coordinates of each country in each Principal Component (PC) in the global solution (Fig. 3), while vectors represent the component loadings of the relevant variables for the 4 PC. The square of the original length ([-1,1]) of the vectors from the origin up to the component loading point represents the variable's total variance accounted for. In this case, vectors were elongated to allow a better understanding of the relation between object scores and component loadings. Shorter vectors are those of the variables determining PC3 and PC4, which are not represented in this two-dimensional plot, but are however relevant for the interpretation of the global results. The circles around high concentrations of object scores highlight the two informal clusters observed in the results.

presenting a two-dimensional nested solution.¹⁴ Fig. 3 highlights the behavior of each country regarding PC1 and PC2; thus, the groups found in this figure can be either observed from the perspective of each PC or as global clusters formed considering the big picture of both PC taken together.

The plot shows the distribution of countries among the two PC, revealing China as a clear outlier for PC2 (see the secondary plot, embedded in Fig. 3). Regarding the remaining country scores (principal plot), Fig. 3 shows that Myanmar, Finland, Germany, Liechtenstein, and Colombia also lie far from the other points in the PC2 perspective, while no evident outliers can be identified for PC1.

¹⁴ These plots represent the solutions for dimensions 1 and 2 (within the global solution of 4 PC), which account for 71.55% of the total variance explained by the 4 retained PC, i.e., the dimensions comprising the most relevant findings. The alternative four-dimensional solution, plotted in a scatterplot matrix representing every dimension against every other in a series of two-dimensional scatterplots, would provide confusing interpretations.

Table 4

Categorical Principal Components Analysis results: model diagnostics for supervision. Variance accounted for by each principal component and its internal consistency using Kaiser and scree plot criteria.

<i>Model diagnostics</i>						
<i>PC</i>	<i>Kaiser criterion</i>			<i>Scree plot criterion</i>		
	<i>Cronbach's alpha</i>	<i>Total (Eigenvalue)</i>	<i>% of Variance</i>	<i>Cronbach's alpha</i>	<i>Total (Eigenvalue)</i>	<i>% of Variance</i>
1	0.817	4.582	19.920	0.859	5.593	24.319
2	0.704	3.066	13.331	0.732	3.331	14.484
3	0.585	2.268	9.861	0.696	2.995	13.021
4	0.552	2.117	9.206			
5	0.491	1.886	8.202			
6	0.449	1.754	7.625			
7	0.320	1.442	6.270			
8	0.081	1.085	4.716			
9	0.022	1.021	4.440			
Total	0.991^a	19.221	83.571	0.958^a	11.919	51.824

Source: Authors' calculations.

^a Total Cronbach's Alpha is based on the total Eigenvalue.

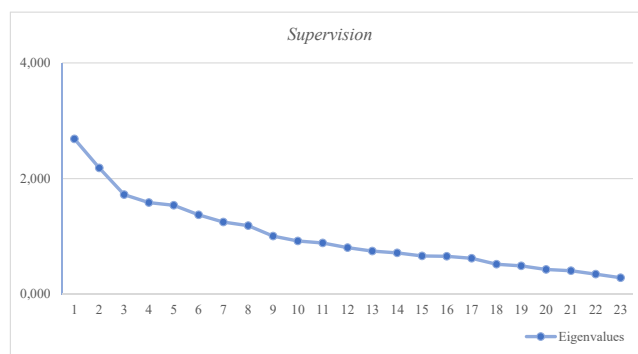


Fig. 5. Scree plot, supervision. Source: Authors' calculations. Scree plot results from *Categorical Principal Components Analysis* estimates for 35 variables, including 23 as analysis variables (corresponds to the number of principal components in the graphic) and the remaining as supplementary variables.

Regarding deposit insurance practices (PC1), a deeper analysis of Fig. 3 reveals that countries may be divided into two main groups. The largest group, on the left side, includes all the developed countries in the sample (except New Zealand, which, unlike most developed countries, has no explicit deposit insurance scheme), and a second group comprising New Zealand and 32 developing countries (including China) on the right side. See Table A3 in Appendix A for the object scores of each country by PC. The maximum and minimum scores for PC1 are observed for China and Germany, which present opposite practices related to deposit insurance. Germany has an explicit deposit insurance system in which the deposit insurance authority has the legal power to cancel or revoke this protection for any bank. Furthermore, an ex-ante reserve exists to cover deposit insurance claims in case of failure of a member bank, and the premiums charged to participant banks vary according to an assessment of risk. The last time a bank failed, the insured deposits (and even some not explicitly covered) were wholly compensated. In comparison, China does not have any depositor protection scheme.

In contrast to PC1, PC2 displays country scores mainly ranging from -1 to 1 , with only the exceptions referred to before. The object scores are standardized with approximately zero mean and unit standard deviation; hence, country scores for this component are relatively homogeneous, and the practices regarding requirements on banking licensing, liquidity diversification, and credit seem to be relatively similar across most countries. The extreme scores for China in PC2 result from the absence of response for some variables and different practices concerning the legal requirements before issuance of the banking license (variable 1.6) and the criteria to classify loans and advances as non-performing (variable 9.2). To be classified as non-performing in China, credit must meet all the criteria listed in variable 9.2,¹⁵ and additional issues related to risk management and historical records must be met. Notably, as for PC1,

¹⁵ a. Significant financial difficulty of the borrower and deterioration in its creditworthiness; b. Breach of contract (e.g., default or delinquency in interest or principal payments); c. Restructuring (i.e., a concession granted for economic or legal reasons relating to the borrower's financial difficulty that the lender would not otherwise consider); d. Borrower bankruptcy or other financial reorganization; e. Days past due status; and f. Existence of collateral, guarantees, and/or other credit mitigants

Table 5

Principal Components (PC) composition, supervision. Bold values represent component loadings above 0.5. Variables with higher correlations in each PC determined its label.

Principal component 1 Supervision institutional structure and mandate				
Variables	Component loadings			
	PC1	PC2	PC3	
12.1 What body/agency supervises commercial banks for prudential purposes?	0.707	-0.263	0.075	
12.3.2 Can the supervisory authority force a bank to change its internal organizational structure?	0.904	-0.290	0.056	
12.4 To whom is the supervisory agency legally responsible or accountable?	0.589	-0.227	0.108	
12.5 How is the head of the supervisory agency appointed?	0.910	-0.279	0.048	
12.6 Does the head of the supervisory agency have a fixed term?	0.860	0.161	-0.120	
12.7 Can the head of the supervisory agency be removed by ...	0.866	0.189	-0.127	
12.9 Can individual supervisory staff be held personally liable for damages to a bank caused by their actions or omissions committed in the good faith exercise of their duties?	0.733	-0.074	-0.010	
12.12 If an infraction of any prudential regulation is found in the course of supervision, must it be reported?	0.535	-0.278	0.091	
12.12.1 Are there mandatory actions that the supervisor must take in these cases?	0.620	-0.245	0.076	
Principal component 2 Discipline: enforcement and resolution				
Variables	Component loadings			
	PC1	PC2	PC3	
11.1 Please indicate whether the following enforcement powers are available to the supervisory agency: a. Cease and desist-type orders for imprudent bank practices; f. Require banks to constitute provisions to cover actual or potential losses; j. Require banks to reduce or suspend dividends to shareholders; k. Require banks to reduce or suspend bonuses and other remuneration to bank directors and managers		0.220	0.686	-0.268
11.5a. Which authority has the powers to perform the following problem bank resolution activities? a. Declare insolvency		0.318	0.823	-0.317
11.5b. Which authority has the powers to perform the following problem bank resolution activities? b. Supersede shareholders' rights		0.207	0.776	-0.226
11.5c. Which authority has the powers to perform the following problem bank resolution activities? c. Remove and replace bank senior management and directors		0.198	0.793	-0.261
Principal component 3 Exit: insolvency				
Variables	Component loadings			
	PC1	PC2	PC3	
11.4 Is there a separate bank insolvency framework that is distinct from that of non-financial firms?	0.072	0.282	0.631	
11.5e. Which authority has the powers to perform the following problem bank resolution activities? e. Appoint and oversee a bank liquidator/receiver	0.049	0.286	0.885	
11.6 Is court approval required for the following bank resolution activities? b. Supersede shareholders' rights; c. Remove and replace bank senior management and directors; e. Appoint and oversee a bank liquidator/receiver	0.068	0.321	0.810	
11.7 Can the bank shareholders appeal to the court against a resolution decision of the banking supervisor?	-0.050	-0.314	-0.870	

Source: Authors' calculations.

Germany's country score for PC2 is again one of the most stringent. This result occurs mainly because, in Germany, a supervisory agency grants commercial banking licenses (variable 1.1), while central banks grant licenses in most of the sampled countries. Furthermore, German banks have no uniform assessment criteria to classify loans and advances as non-performing (variable 9.2). Instead, based on the German commercial code and accounting rules, banks have the discretion to conduct their assessments.

Complementarily, Fig. 4 shows a joint representation of countries' scores and component loadings to help identify the variables in which countries follow similar practices. In this plot, the coordinates of the countries are the same as in Fig. 3; however, the vectors (which initially vary between -1 and 1) representing each variable are elongated by default (to the scale of objects) to allow a representation of the component loadings in the same space of the objects.¹⁶ Fig. 4 represents the global solution for the whole sample, including the outlier China, in the secondary plot, while the main plot enlarges the country scores to allow precise observation of the position of each country.

Based on the estimated coordinates, countries in the same group have similar banking regulation practices related to the variables whose correspondent vectors are closer to each country point. Thus, Fig. 4 allows us to conclude, for example, that Myanmar, Finland, Germany, Liechtenstein, and Colombia have similar practices related to banking licenses for commercial banks (variable 1.1), sources of funds for capital (variable 1.4.2), liquidity requirements (variables 7.4 and 7.4.1), and external credit ratings (10.7). Furthermore, developing countries present similar deposit insurance practices (relevant questions of BRSS's group 8), and Israel, Belize, Samoa, and Burundi have analogous disclosure rules for off-balance sheet items related to governance and risk management frameworks (variable 10.5.1). Fig. 4 also suggests that two (informal) country clusters exist and highlights the RS practices justifying them. Cluster 1 mainly comprises developed countries that observe identical frameworks for complementary banking activities (variables 2.5.1, 4.1, 4.2, and 4.3), entry of new banks requirements (variable 1.13), and the proportion of total deposits effectively converted into depositors' protection schemes (variable 8.11). Cluster 2 includes only developing countries that share similar practices on deposit insurance (group 8 variables) and market discipline (variable 10.5.1).

¹⁶ An additional adjustment in the maximum scale of PC2 was made to exclude China from the plot.

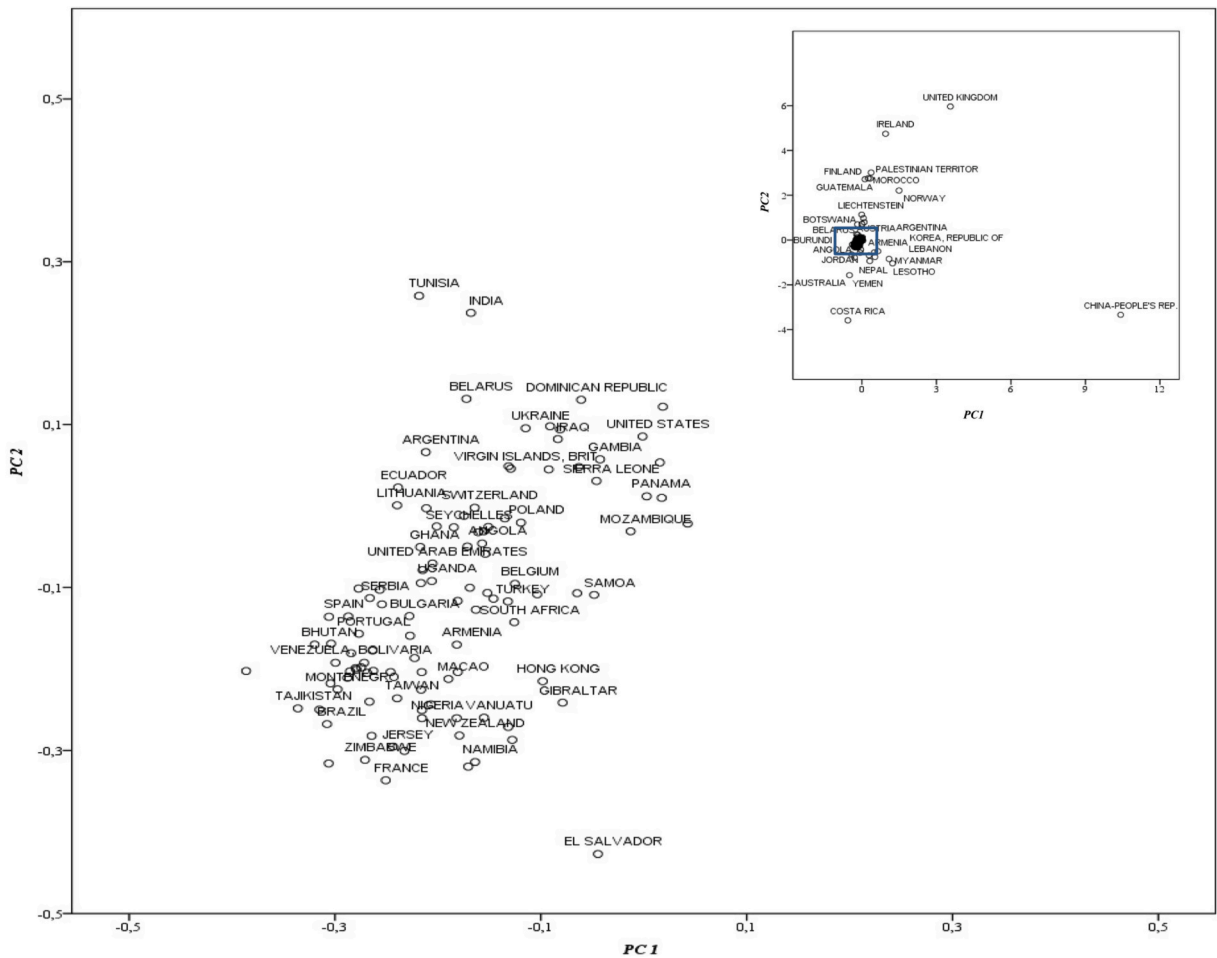


Fig. 6. Object plots labeled by country, supervision. principal normalization. Source: Authors' calculations. Country scores from *Categorical Principal Components Analysis* on 35 variables, (23 as analysis variables and 12 supplementary variables). The points in the object scores plot represent the coordinates of each country in each principal component with, approximately, zero mean and unit standard deviation.

4.2. Supervision

4.2.1. Principal components selection

For supervision, selecting the PC was also conducted by applying the Kaiser rule and the scree plot technique (Table 4). Following the Kaiser criterion, we can summarize all supervisory practices in 9 PC, explaining 83.57% of the total variance or, according to the scree plot method (Table 4 and Fig. 5), in 3 principal components explaining 51.82% of the original dataset's total variance. The C-alpha coefficient is above 0 for all PC in both methods, showing its internal consistency.

Table A4 (see Appendix A) identifies the supervisory variables contributing to each dimension based on its component loadings. In this table, bold values in light shading represent component loadings above 0.5 in absolute value, meaning that such variables are determinants for the corresponding PC. Hence, both outputs (Kaiser criterion and scree plot method) recognize that the characteristics that best determine banking supervision include supervision of the institutional structure and mandate (variables 12.1, 12.3.2, 12.4, 12.5, 12.6, 12.7, 12.9, 12.12, and 12.12.1); discipline, enforcement, and resolution (variables 11.1, 11.5.a., 11.5.b., and 11.5.c.); and problem institutions and exit (variables 11.4, 11.5e, 11.6, and 11.7).

4.2.2. The most relevant aspects of supervision

Regarding regulation, the scree plot method is also assumed as the preferable model for supervision results. Consequently, the original set of variables might be reduced into 3 PC, with each component labeled according to the most relevant variables explaining each. Thus, PC1 is labeled *supervision institutional structure and mandate*, while PC2 is *discipline: enforcement and resolution actions*, and PC3 may be called *exit: insolvency*. Table 5 presents each PC composition and label.

Based on the observed results, we assume that the structure and mandate of supervisory agencies, the authority in charge of the resolution powers and insolvency frameworks, and infraction reports in prudential regulation are the main proxies to measure banking supervision. These conclusions corroborate previous studies defending similar practices as significant concerns regarding supervision

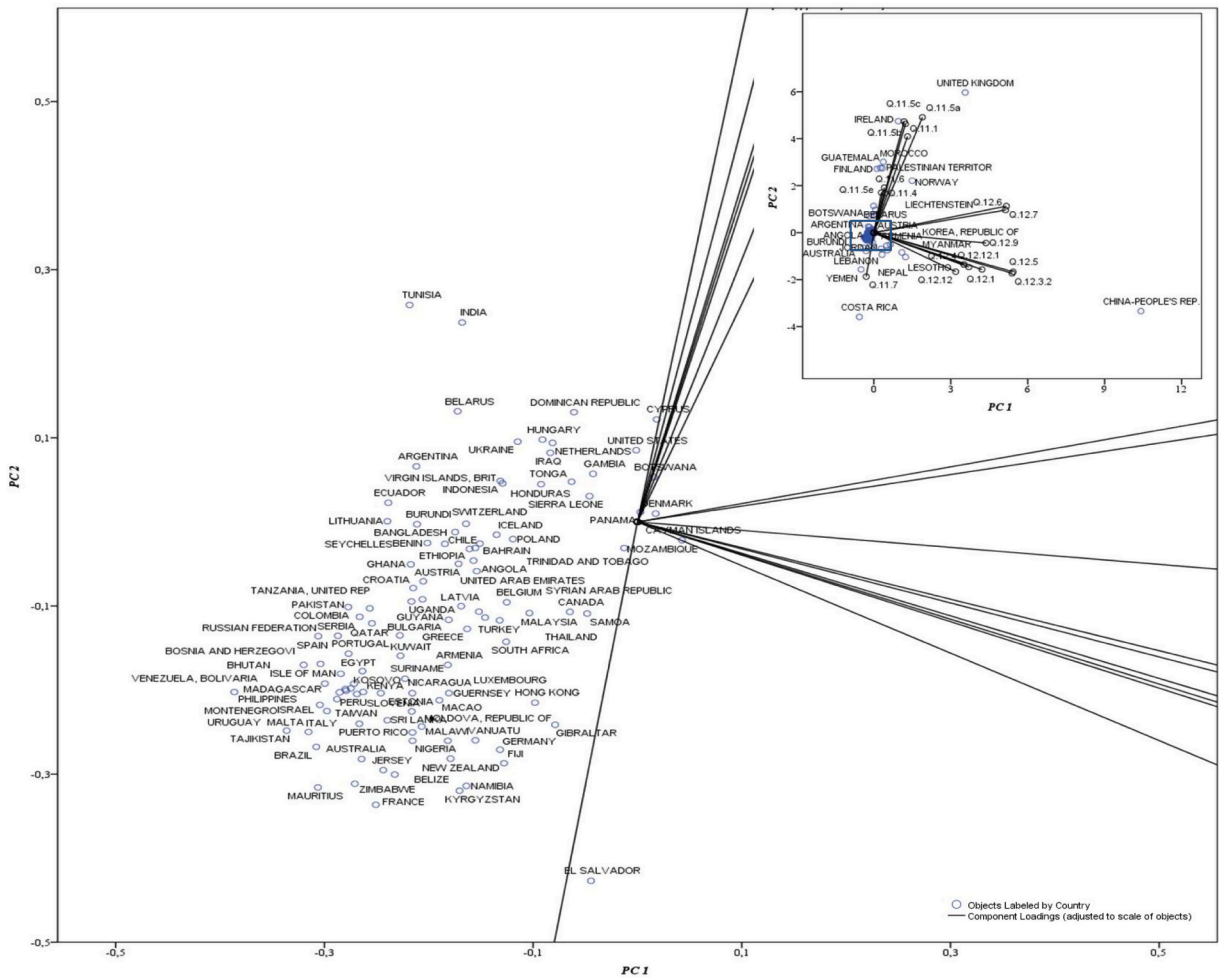


Fig. 7. Biplot of objects and component loadings, supervision. Variable principal normalization. Source: Authors' calculations. Plot of country scores (the points) and component loadings (the vectors) from *Categorical Principal Components Analysis* on the relevant variables to determine supervision. The points are the coordinates of each country in each Principal Component (PC) in the global solution (Fig. 6), while vectors represent the component loadings of the relevant variables for the 3 PC. The square of the original length ([-1,1]) of the vectors from the origin up to the component loading point represents the variable's total variance accounted for. In this case, vectors were elongated to allow a better understanding of the relation between object scores and component loadings. Shorter vectors are those of the variables determining PC3, which are not represented in this two-dimensional plot, but are however relevant for the interpretation of the global results. The circle around the highest concentration of object scores highlights the single informal cluster observed for supervision results.

structures, such as the importance of independent¹⁷ (Eichengreen and Dincer, 2001) or supranational (Beck and Wagner, 2016) supervisors, the extent of information included in supervisory reports (Neyapti and Dincer, 2005), or the head of the supervisory contract term and supervisory agency powers (Barth et al., 2013b).

4.2.3. Country clusters

The plot of object scores (Fig. 6) is a two-dimensional nested solution representing the coordinates of each country in PC1 and PC2, which confirms that China has the most distinct RS practices. As for regulation, in terms of supervision, China is an extreme outlier for one of the PC (this time PC1) and displays one of the highest scores for the other PC. The United Kingdom also displays extreme scores for both components.

Regarding PC1, China distances itself from the remaining countries primarily because it did not provide answers for some specific practices. At the same time, the UK's detachment from the rest of the sample is mainly related to the finance minister appointing the head of the supervisory agency (variable 12.5) (most countries identified the head of government as being responsible for such nomination) and the inexistence of mandatory actions taken by a supervisor in case of infraction of any prudential regulation found during supervision actions (variable 12.12.1), which are observed in 100 sampled countries. Furthermore, in the UK, commercial

¹⁷ From governmental bodies.

Table 6

Regulation variables by sub-sample and Principal Component (PC). Table supporting the robustness checks, confirming the variables that best characterize regulation practices around the world, regardless of the sample composition. Bold text refers to relevant variables determining PC in all subsamples. If the PC is the same in all subsamples, then the text is also in light shading. Please note that Colombia, Latvia and Lithuania were admitted in OECD in 2020, 2016 and 2018, respectively. Hence, they were not members during data collection for the survey and, for this reason, they were not included as OECD countries in this robustness check. Offshore countries list source: list of countries, territories, and jurisdictions with offshore financial centers from the “Offshore financial centers IMF background paper”, available on-line on 06/10/2020 at: <https://www.imf.org/external/np/mae/oshore/2000/eng/back.htm>.

Variables - regulation	All sample	OECD	Non offshore	Offshore
1.1 What body/agency grants commercial banking licenses? Please include the name of licensing agency. If more than one, please describe their respective licensing roles.	PC2	PC3	PC2	PC1
1.3 Is more than one license required (e.g. one for each banking activity, such as deposit-taking, consumer lending etc.)?	-	-	-	PC2
1.4.2 Are the sources of funds to be used as capital verified by the regulatory/supervisory authorities?	PC2	-	PC2	-
1.6 Which of the following are legally required to be submitted before issuance of the banking license?	PC2	PC1	PC2	-
1.7a. In the past 5 years (2006–2010), how many applications for commercial banking licenses from domestic entities (i.e. those 50% or more domestically owned) have been: a.Received	-	-	-	PC2
1.7b. In the past 5 years (2006–2010), how many applications for commercial banking licenses from domestic entities (i.e. those 50% or more domestically owned) have been: b.Denied	-	-	-	PC2
1.10a. In the past 5 years (2006–2010), how many applications from foreign banks to enter through the acquisition of a domestic bank were a. Received	-	-	-	PC2
1.10b. In the past 5 years (2006–2010), how many applications from foreign banks to enter through the acquisition of a domestic bank were b. Denied	-	-	-	PC2
1.10c. In the past 5 years (2006–2010), how many applications from foreign banks to enter through the acquisition of a domestic bank were c. Withdrawn	-	-	-	PC2
1.11a. In the past 5 years (2006–2010) how many applications from foreign banks to enter through a new subsidiary were: a. Received	-	-	-	PC2
1.11b. In the past 5 years (2006–2010) how many applications from foreign banks to enter through a new subsidiary were: b. Denied	-	-	-	PC2
1.11c. In the past 5 years (2006–2010) how many applications from foreign banks to enter through a new subsidiary were: c. Withdrawn	-	-	-	PC2
1.12b. In the past 5 years (2006–2010) how many applications from foreign banks to enter by opening a branch were: b. Denied	-	-	-	PC2
1.13 What were the primary reasons for denial of the applications in questions 1.7, 1.10, 1.11 and 1.12?	PC4	-	-	-
2.5.1 Can related parties own capital in a bank?	PC3	PC2	-	-
2.6 Can nonfinancial firms own voting shares in commercial banks? Please see options provided and select option that best characterizes your banking sector	-	PC2	-	PC1
2.7 Can nonbank financial firms (e.g. insurance companies, finance companies, etc.) own voting shares in commercial banks? Please see options provided and select option that best characterizes your banking sector	-	PC2	-	-
3.1 Which regulatory capital adequacy regimes did you use as of end of 2010 and for which banks does each regime apply to (if using more than one regime)? Mark the appropriate response below and specify for which types of banks each regime applies	-	PC2	-	PC1
3.2 Which risks are covered by the current regulatory minimum capital requirements in your jurisdiction? Please specify all applicable risks.	-	-	-	PC1
4.1 What are the conditions under which banks can engage in securities activities?	PC3	PC2	-	PC1
4.2 What are the conditions under which banks can engage in insurance activities?	PC3	PC2	-	PC1
4.3 What are the conditions under which banks can engage in real estate activities?	PC3	PC2	-	PC1
4.4.1 Can banks own voting shares in nonfinancial firms? Please mark the option that best characterizes the situation in your jurisdiction.	-	-	-	PC2
7.2 Are there any regulatory rules or supervisory guidelines regarding asset diversification?	PC2	-	PC2	-
7.2.2 Are banks prohibited from making loans abroad?	PC2	-	PC2	-
7.4 Are the following requirements in place in your jurisdiction? b. Central Bank reserve and/or deposit requirements.	PC2	PC3	PC2	-
7.4.1 Are banks required to hold reserves in foreign currencies or other foreign-denominated instruments in order to fulfill the requirements listed above?	PC2	-	PC2	-
8.1 Is there an explicit deposit insurance protection system for commercial banks?	PC1	PC1	PC1	PC1
8.4 Does the deposit insurance agency/fund administrator have the following powers as part of its mandate? c. Bank intervention authority.	PC1	PC1	PC1	PC1
8.4.1 Does the deposit insurance authority by itself have the legal power to cancel or revoke deposit insurance for any participating bank?	PC1	PC1	PC1	PC1
8.4.2 Can the deposit insurance agency/fund take legal action for violations against laws, regulations, and bylaws (of the deposit insurance agency) against bank directors or other bank officials?	PC1	PC1	PC1	PC1
8.4.3 Has the deposit insurance agency/fund ever taken legal action for violations against laws, regulations, and bylaws (of the deposit insurance agency) against bank directors or other bank officials?	PC1	PC1	PC1	PC1
8.5 Is participation in the deposit insurance system compulsory for the following banking entities?	PC1	PC1	PC1	PC1
8.6 Are the following types of deposits excluded from deposit insurance coverage?	PC1	PC1	PC1	PC1
8.7 The deposit insurance coverage type is: a. Per depositor account; b. Per depositor; c. Per depositor per institution; d. Other (please explain).	PC1	PC1	PC1	PC1
8.10 Is there formal coinsurance, i.e. are ALL depositors explicitly insured for less than 100% of their deposits?	PC1	PC1	PC1	PC1
8.11 What percentage of the total deposits of participating commercial banks was actually covered by the scheme as of end of 2010?	PC1	PC1	PC1	PC1

(continued on next page)

Table 6 (continued)

Variables - regulation	All sample	OECD	Non offshore	Offshore
8.11.1 As a share of total assets, what is the value of large denominated debt liabilities of banks (e.g. subordinated debt, bonds, etc.) that are definitely not covered by any explicit or implicit savings protection scheme?	-	-	-	PC1
8.12 Is there an ex ante fund/reserve to cover deposit insurance claims in the event of the failure of a member bank?	PC1	PC1	PC1	PC1
8.13 Funding is provided by: a. Government; b. Banks; c. Combination/Other (please explain).	PC1	PC1	PC1	PC1
8.13.1 If prefunded, what is the ratio of accumulated funds to total bank assets as of end of 2010?	-	-	-	PC1
8.14 Do deposit insurance fees/premiums charged to banks vary based on some assessment of risk?	PC1	PC1	PC1	PC1
8.17.1 In general, how long (in days) does it take in practice to pay depositors in full?	-	-	-	PC2
8.17.2 Were insured depositors wholly compensated (to the extent of legal protection) the last time a bank failed?	PC1	PC1	PC1	PC2
8.17.3 Were any deposits not explicitly covered by the deposit insurance scheme at the time of failure compensated the last time a bank failed (excluding funds later paid out in liquidation procedures)?	PC1	PC1	PC1	-
9.1 Do you have an asset classification system under which banks have to report the quality of their loans and advances using a common regulatory scale?	-	-	-	PC1
9.1.3b After how many days is a loan in arrears classified as ...?: b. Doubtful?	-	-	-	PC1
9.1.3c After how many days is a loan in arrears classified as ...?: c. Loss?	-	-	-	PC1
9.2 Which criteria are taken into account to classify loans and advances as non-performing ...?:	PC2	PC2	PC2	PC2
9.6.3a What is the minimum provisioning required as loans become ... a. Sub-standard?	-	-	-	PC1
9.6.3b What is the minimum provisioning required as loans become ... b. Doubtful?	-	-	-	PC1
10.2.1 Are applicable accounting standards for banks in your country prepared in accordance with U.S. Generally Accepted Accounting Principles (GAAP)?	-	-	-	PC2
10.2.2 Are applicable accounting standards for banks in your country prepared in accordance with IFRS?	-	-	-	PC2
10.5.1 Do banks disclose to the public ...? b. Off-balance sheet items; c. Governance and risk management framework	PC4	PC1	-	PC1
10.7 Are commercial banks required by supervisors to have external credit ratings?	PC2	-	PC2	-
Number of sampled countries	141	31	118	23

Source: Authors' calculations.

banks are supervised for prudential purposes by a single bank supervisory agency (variable 12.1), while the central bank supervises most sampled countries.

For discipline: enforcement and resolution practices (PC2), the most distinct practices are adopted by the UK and Ireland, on the one hand, and Costa Rica and China, in the opposite direction. Ireland is the only country whose enforcement powers available to the supervisory agency (variable 11.1) are limited to “cease and desist-type orders for imprudent bank practices” and “require banks to reduce or suspend bonuses and other remuneration to bank directors and managers.” The UK is the single sampled country that shares the power to declare bank insolvency (variable 11.5a) with the court and other authorities, namely, the former Financial Services Authority (operating when BRSS took place and currently replaced by the Prudential Regulation Authority and the Financial Conduct Authority), the Bank of England (BoE), and Her Majesty’s Treasury (HMT), the government’s economic and finance ministry. Furthermore, in Ireland and the UK, the powers to supersede shareholders’ rights (variable 11.5b) and to remove and replace bank senior management and directors (variable 11.5c) (which are mainly assumed by the bank supervisor in most sampled countries) are assigned to different authorities. In Ireland, these powers are performed by the finance minister. At the same time, in the UK, bank resolution shareholders’ rights are supplanted by the BoE acting as resolution authority under the Special Resolution Regime (SRR), and the actions to remove and replace bank senior management and directors are conducted by the BoE or by HMT, under the SRR. On the other extreme, unlike most countries where the power to declare banks’ insolvency is assigned to the court, in Costa Rica and China, it is a bank supervisor competency.

More details on the divergences across countries concerning specific supervisory practices are pictured in Fig. 7, showing the UK and Ireland dissociating from the remaining countries in practices regarding actions to declare insolvency of banks and remove and replace bank senior management and directors (shown by the proximity of such countries’ scores to the vectors related to variables 11.5a and 11.5c). Fig. 7 only highlights one evident (informal) cluster, concerning mostly PC1 determinant variables. This cluster is formed by developing countries, meaning that such countries follow similar practices on supervision institutional structure and mandate. Table A5 in Appendix A presents the object scores regarding supervision practices by PC.

4.3. Discussion and robustness

The predominance of developing countries in the sample and the inclusion of offshore territories in the database may have significantly affected the results from the previous sections. We test their robustness, capture economic development potential influence, and investigate the differences induced by the legal frameworks of offshore countries, by repeating the CATPCA estimates, considering only OECD countries, and dividing the sample into offshore and non-offshore countries. Furthermore, we assess the robustness of our results to the missing data strategy adopted.

4.3.1. Robustness on relevant aspects of regulation and supervision

Tables 6 and 7 present the variables that best characterize RS, respectively, by subsample and PC. Bold text indicates variables that are relevant for determining PC in all subsamples; text in light shading indicates when the PC is the same in all subsamples.

For the OECD sample, the scree plot analysis led to the formation of three components for both RS practices, with some reorganization in the PC’s composition. For regulation, PC1 keeps the label *deposit insurance*, but PC2 is now called *complementary banking*

Table 7

Supervision variables by sub-sample and Principal Component (PC). Table supporting the robustness checks, confirming the variables that best characterize supervision practices around the world, regardless of the sample composition. Bold text refers to relevant variables determining PC in all subsamples. Please note that Colombia, Latvia and Lithuania were admitted in OECD in 2020, 2016 and 2018, respectively. Hence, they were not members during data collection for the survey and, for this reason, they were not included as OECD countries in this robustness check. Offshore countries list source: list of countries, territories and jurisdictions with offshore financial centers from the “Offshore financial centers IMF background paper”, available on-line on 06/10/2020 at: <https://www.imf.org/external/np/mae/oshore/2000/eng/back.htm>.

Variables - supervision	All sample	OECD	Non offshore	Offshore
5.10 Does the banking supervisor have the right to meet with the external auditors and discuss their report without the approval of the bank?	-	-	PC3	PC4
5.12 In cases where the supervisor identifies that the bank has received an inadequate audit, does the supervisor have the powers to take actions against ... b. The external auditor	-	-	PC3	-
10.5 Do banks disclose to the supervisors ...?: b. Off-balance sheet items	-	PC3	PC3	-
11.1 Please indicate whether the following enforcement powers are available to the supervisory agency: a. Cease and desist-type orders for imprudent bank practices; f. Require banks to constitute provisions to cover actual or potential losses; j. Require banks to reduce or suspend dividends to shareholders; k. Require banks to reduce or suspend bonuses and other remuneration to bank directors and managers	PC2	PC1	-	-
11.3 Does the supervisory agency operate an early intervention framework (e.g. prompt corrective action) that forces automatic action when certain regulatory triggers/thresholds are breached?	-	-	-	PC4
11.4 Is there a separate bank insolvency framework that is distinct from that of non-financial firms?	PC3	-	-	-
11.5a. Which authority has the powers to perform the following problem bank resolution activities? a. Declare insolvency	PC2	PC1	-	PC2
11.5b. Which authority has the powers to perform the following problem bank resolution activities? b. Supersede shareholders' rights	PC2	-	PC2	-
11.5c. Which authority has the powers to perform the following problem bank resolution activities? c. Remove and replace bank senior management and directors	PC2	PC3	PC2	PC1
11.5e. Which authority has the powers to perform the following problem bank resolution activities? e. Appoint and oversee a bank liquidator/receiver	PC3	PC1	PC2	PC1
11.6 Is court approval required for the following bank resolution activities? b. Supersede shareholders' rights; c. Remove and replace bank senior management and directors; e. Appoint and oversee a bank liquidator/receiver	PC3	PC2	-	PC1
11.7 Can the bank shareholders appeal to the court against a resolution decision of the banking supervisor?	PC3	PC2	-	PC1
12.1 What body/agency supervises commercial banks for prudential purposes?	PC1	-	-	-
12.3.2 Can the supervisory authority force a bank to change its internal organizational structure?	PC1	PC2	-	-
12.4 To whom is the supervisory agency legally responsible or accountable?	PC1	PC2	PC1	-
12.5 How is the head of the supervisory agency appointed?	PC1	PC2	-	-
12.6 Does the head of the supervisory agency have a fixed term?	PC1	PC1	PC1	PC2
12.7 Can the head of the supervisory agency be removed by ...	PC1	PC1	PC1	PC2
12.9 Can individual supervisory staff be held personally liable for damages to a bank caused by their actions or omissions committed in the good faith exercise of their duties?	PC1	-	PC1	PC1
12.12 If an infraction of any prudential regulation is found in the course of supervision, must it be reported?	PC1	PC3	PC1	PC4
12.12.1 Are there mandatory actions that the supervisor must take in these cases?	PC1	-	PC1	PC3
12.6 Does the head of the supervisory agency have a fixed term? 12.6.1 If yes, how long (in years) is the term?	-	-	-	PC2
12.38 How many of the bank supervisors have more than 10 years experience in bank supervision?	-	-	-	PC1
12.39 What is the average tenure of banking supervisors (i.e. what is the average number of years that staff have been supervisors)?	-	-	-	PC1
Number of sampled countries	141	31	118	23

Source: Authors' calculations.

activities and capital ownership, and PC 3 is defined as *entry into banking and capital adequacy*. Supervision output also resulted in a different variable organization contributing to each PC; however, only variable 10.5 (banks off-balance sheet disclosure to supervisors) appears as a new relevant practice to explain banking supervision.

Regarding regulation, the ownership and capital variables (2.6, 2.7, and 3.1) are relevant only for the OECD subsample. These results suggest that the rules toward voting shares (variables 2.6 and 2.7) and the unique variable truly related to capital requirements (variable 3.1, application of capital adequacy regimes), which were stated in previous studies as major regulatory concerns (Moosa, 2010; Aiyar et al., 2015; Jacques, 2017), are of minor relevance for countries outside OECD. This low expression of capital variables determining PC in regulation was shown in Section 4.1.2, indicating that, for the whole sample, only the ownership question 2.5.1 was a determinant for PC3.

Because most sampled countries (118) are non-offshore countries, it is unsurprising that the results for this subgroup are consistent with the observed for the total sample. Nevertheless, in this case, the scree plot method established only two PC for regulation: PC1, determined by *deposit insurance* practices, and PC2, defined by *liquidity and diversification regulatory requirements*. For supervision, three PC were defined: PC1, composed of *agency powers and liability and report of infractions*; PC2, determined by *bank resolution variables*; and PC3, defined by the *relationship between the banking supervisor and the external auditor* (5.12) and *banks off-balance sheet disclosure to supervisor* (variable 10.5). In contrast, some differences were found for offshore countries compared to the total sample. The number of PC increased to 4 for supervision, and 24 new variables became relevant (20 for regulation and 4 for supervision). The PC's definition for offshore countries remains similar for supervision, with the other PC concerning early intervention frameworks conducted by the supervisory agency. For regulation, PC has changed slightly and is now defined as deposit insurance, assets and loans classification

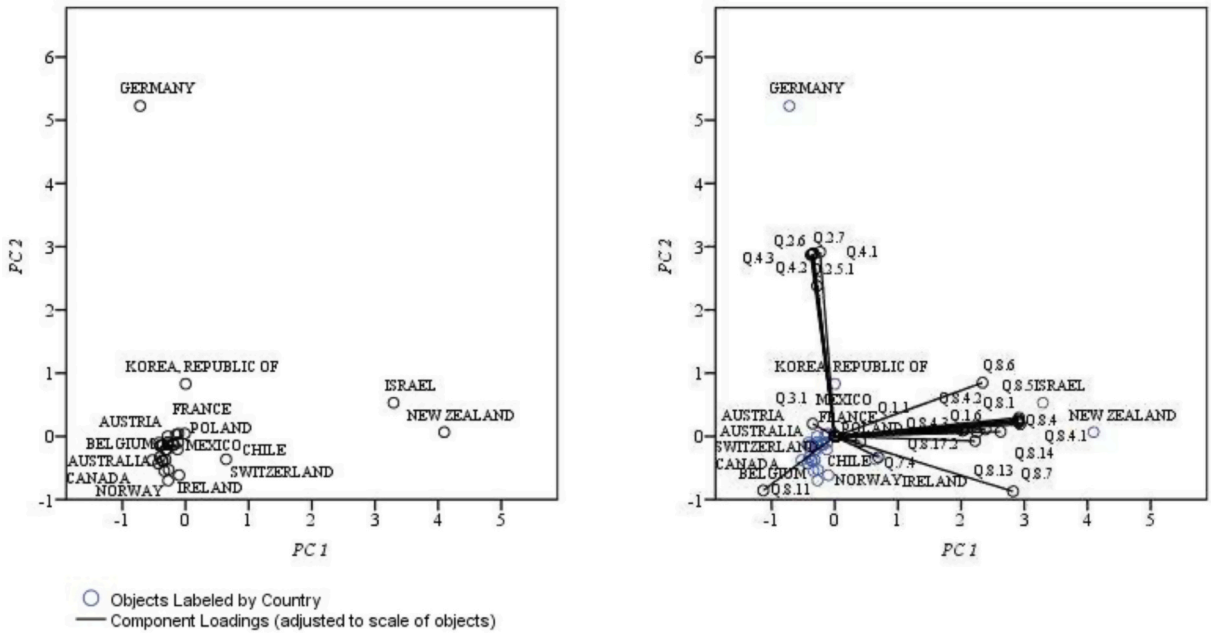


Fig. 8. Plots of objects and component loadings, OECD countries, regulation. Variable principal normalization. Source: Authors' calculations. Plot of country scores (the points) on the left and biplot of country scores and component loadings (the vectors) on the right from *Categorical Principal Components Analysis* on the relevant variables to determine regulation (OECD countries only). The points in both plots are the coordinates of each OECD country in each Principal Component (PC), while vectors represent the component loadings of the relevant variables for the 3 PC. The square of the length of the vectors from the origin up to the component loading point represents the variable's total variance accounted for.

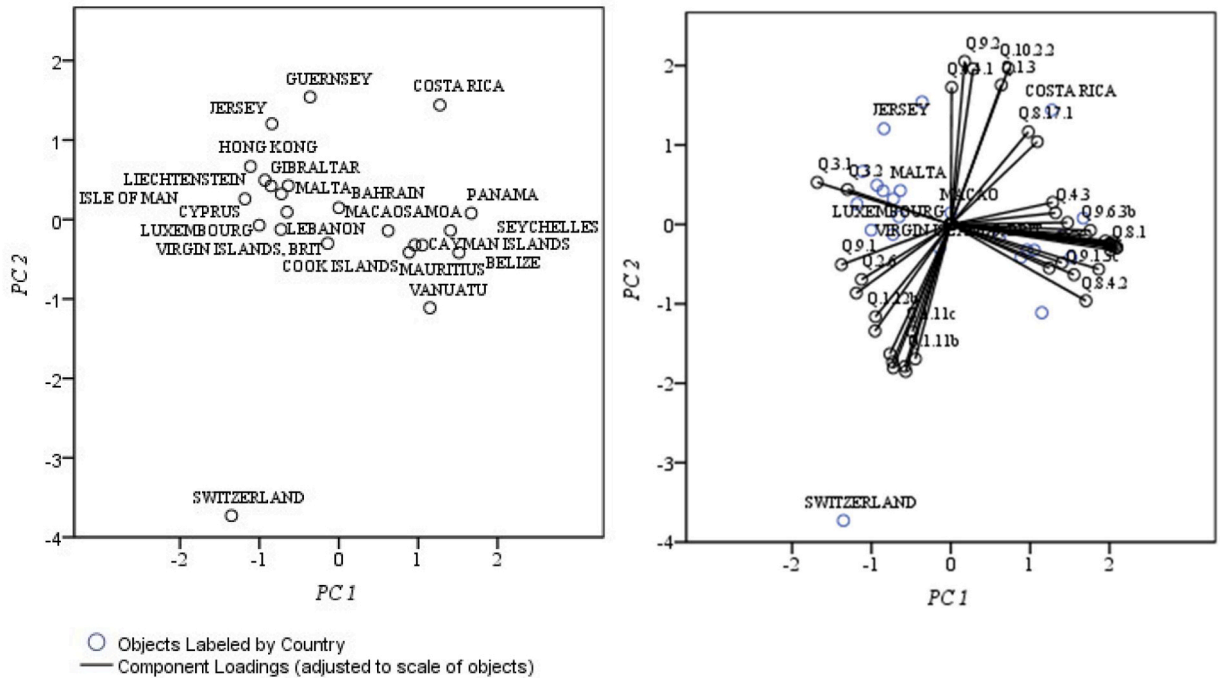


Fig. 9. Plots of objects and component loadings, offshore countries, regulation. Variable principal normalization. Source: Authors' calculations. Plot of country scores (the points) on the left and biplot of country scores and component loadings (the vectors) on the right from *Categorical Principal Components Analysis* on the relevant variables to determine regulation (offshore countries only). The points in both plots are the coordinates of each offshore country in each Principal Component (PC), while vectors represent the component loadings of the relevant variables for the 2 PC. The square of the length of the vectors from the origin up to the component loading point represents the variable's total variance accounted for.

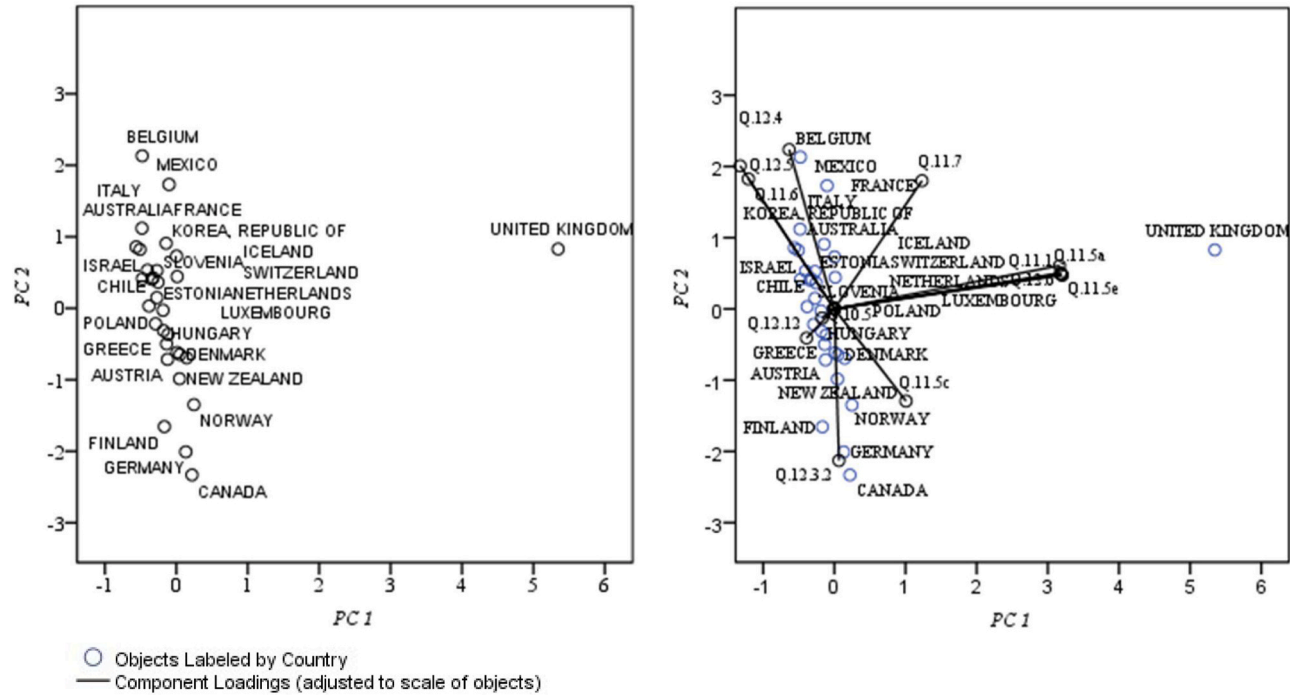


Fig. 10. Plots of objects and component loadings, OECD countries, supervision. Variable principal normalization. Source: Authors' calculations. Plot of country scores (the points) on the left and biplot of country scores and component loadings (the vectors) on the right from *Categorical. Principal Components Analysis* on the relevant variables to determine supervision (OECD countries only). The points in both plots are the coordinates of each OECD country in each Principal Component (PC), while vectors represent the component loadings of the relevant variables for the 3 PC. The square of the length of the vectors from the origin up to the component loading point represents the variable's total variance accounted for.

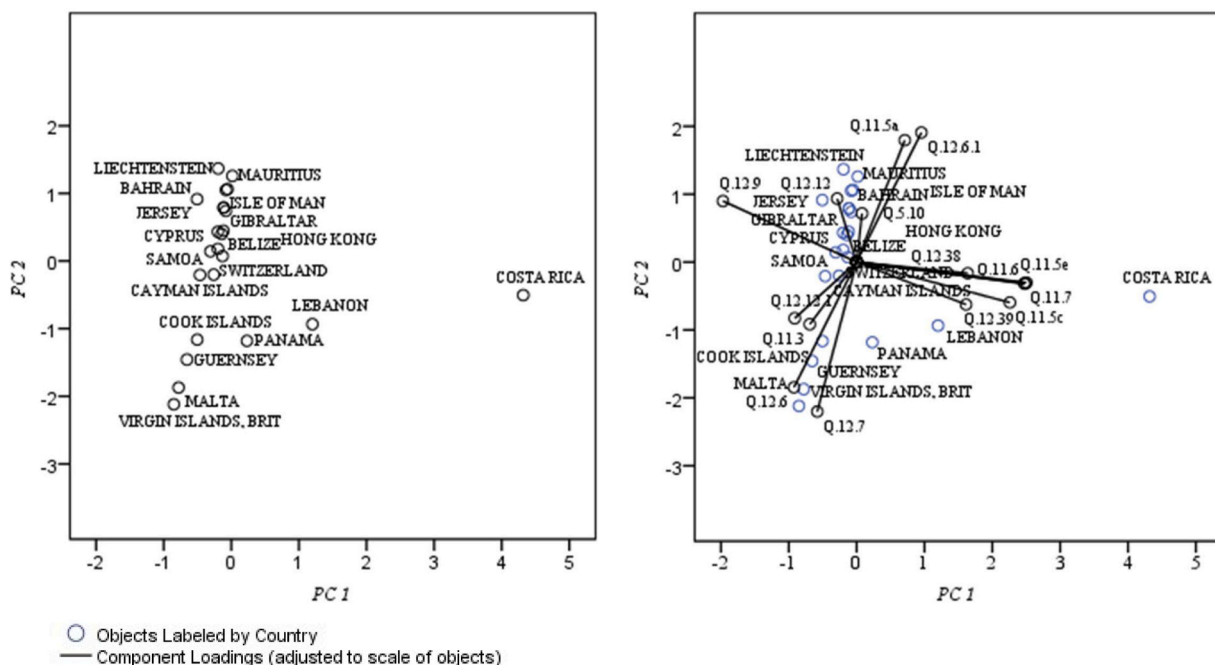


Fig. 11. Plots of objects and component loadings, offshore countries, supervision. Variable principal normalization. Source: Authors' calculations. Plot of country scores (the points) on the left and biplot of country scores and component loadings (the vectors) on the right from *Categorical Principal Components Analysis* on the relevant variables to determine supervision (offshore countries only). The points in both plots are the coordinates of each offshore country in each Principal Component (PC), while vectors represent the component loadings of the relevant variables for the 4 PC. The square of the length of the vectors from the origin up to the component loading point represents the variable's total variance accounted for..

(PC1), and entry into banking, liquidity diversification, and accounting standards (PC2).

Comparing non-offshore and offshore countries indicates that several variables are relevant for one group but not for the other. Namely, eight (six) regulation variables and four (seven) supervision variables are important only for non-offshore (offshore) countries. The most interesting difference between the two groups of countries is the focus on questions related to asset diversification and reserves (variables 7.2, 7.2.2, 7.4, and 7.4.1). This focus is observable for the non-offshores subsample against the relevance of several practices concerning requirements on entry banking (variables from group 1 of the BRSS) and asset and loan classifications (variables 9.1.3, 9.2, and 9.6.3) for offshore countries.

Despite these differences, the robustness of the results for regulation practices is apparent, with the four samples listed in [Table 6](#) showing that variables for deposit insurance are relevant to determine PC1 in all scenarios. Moreover, this first component explains most data variability and presents the highest internal consistency; thus, conclusions support the fact that depositor protection schemes (highlighted variables in light shading for regulation in [Table 6](#)) are critical regulatory practices regardless of countries' development level or legal framework differences.

Supervision comparison across samples is less robust toward a specific PC; however, it supports the relevance of five supervisory practices whose contribution to a PC does not depend on countries' development or jurisdictional discrepancies. Thus, evidence indicates that the most robust practices to explain banking supervision include resolution activities, such as the power to remove and replace bank management and directors (variable 11.5c), appoint and oversee a bank liquidator (variable 11.5e), determine the head of supervisory contract specifications (variables 12.6 and 12.7), and report prudential regulation infractions (variable 12.12).

4.3.2. Robustness on countries' coordinates

The robustness checks show that the countries that displayed the most stringent practices in the original sample maintain such behavior in their subsamples. For example, this finding holds for RS in China (non-offshore subsample), regulation practices in Germany (OECD subsample), and supervision practices in the UK (also OECD subsample) and Costa Rica (offshore subsample). [Figs. 8 and 9](#) present regulation, and [Figs. 10 and 11](#) show supervision. [Figs. 8 and 10](#) are for OECD countries, while the others refer to the offshore subsample.

When analyzed by subsample, countries' coordinates are generally closer, showing that OECD countries, on the one hand, and offshore countries, on the other hand, adopt relatively homogeneous RS policies. The exceptions that stand out from their peer groups are Switzerland (offshore subsample), Israel, and New Zealand (OECD sample), and only in terms of regulation. Israel and New Zealand showed their higher proximity to developing countries concerning PC1 ([Figs. 3 and 4](#) in [Section 4.1.3](#)), which was explained by the absence of an explicit deposit insurance scheme. Regarding Switzerland, [Figs. 8 and 9](#) show that, despite being an offshore jurisdiction, the country's regulation practices are more aligned with those implemented by the OECD countries. [Fig. 9](#) also shows that Switzerland

Table 8

Relevant regulation variables by missing values strategy. Table supporting the robustness checks, confirming the variables that best characterize regulation practices around the world, regardless of the missing values strategy. “✓” refers to relevant variables determining principal components in each strategy.

Variables	Missing values strategy	
	Active treatment	Passive treatment
1.1 What body/agency grants commercial banking licenses? Please include the name of licensing agency. If more than one, please describe their respective licensing roles.	✓	✓
1.4.2 Are the sources of funds to be used as capital verified by the regulatory/supervisory authorities?	✓	-
1.6 Which of the following are legally required to be submitted before issuance of the banking license?	✓	✓
1.13 What were the primary reasons for denial of the applications in questions 1.7, 1.10, 1.11 and 1.12?	✓	✓
2.5.1 Can related parties own capital in a bank?	✓	✓
2.7 Can nonbank financial firms (e.g. insurance companies, finance companies, etc.) own voting shares in commercial banks?	-	✓
3.1 Which regulatory capital adequacy regimes did you use as of end of 2010 and for which banks does each regime apply to (if using more than one regime)?	-	✓
3.2 Which risks are covered by the current regulatory minimum capital requirements in your jurisdiction? Please specify all applicable risks.	-	✓
4.1 What are the conditions under which banks can engage in securities activities?	✓	-
7.2 Are there any regulatory rules or supervisory guidelines regarding asset diversification?	✓	-
7.2.2 Are banks prohibited from making loans abroad?	✓	-
7.4.1 Are banks required to hold reserves in foreign currencies or other foreign-denominated instruments in order to fulfill the requirements listed above?	✓	-
8.1 Is there an explicit deposit insurance protection system for commercial banks?	✓	✓
8.4 Does the deposit insurance agency/fund administrator have the following powers as part of its mandate? c. Bank intervention authority.	✓	✓
8.4.1 Does the deposit insurance authority by itself have the legal power to cancel or revoke deposit insurance for any participating bank?	✓	✓
8.4.2 Can the deposit insurance agency/fund take legal action for violations against laws, regulations, and bylaws (of the deposit insurance agency) against bank directors or other bank officials?	✓	✓
8.4.3 Has the deposit insurance agency/fund ever taken legal action for violations against laws, regulations, and bylaws (of the deposit insurance agency) against bank directors or other bank officials?	✓	✓
8.5 Is participation in the deposit insurance system compulsory for the following banking entities?	✓	✓
8.6 Are the following types of deposits excluded from deposit insurance coverage?	✓	✓
8.7 The deposit insurance coverage type is: a. Per depositor account; b. Per depositor; c. Per depositor per institution; d. Other (please explain).	✓	✓
8.10 Is there formal coinsurance, i.e. are ALL depositors explicitly insured for less than 100% of their deposits?	✓	✓
8.11 What percentage of the total deposits of participating commercial banks was actually covered by the scheme as of end of 2010?	✓	-
8.12 Is there an ex ante fund/reserve to cover deposit insurance claims in the event of the failure of a member bank?	✓	✓
8.13 Funding is provided by: a. Government; b. Banks; c. Combination/Other (please explain).	✓	✓
8.14 Do deposit insurance fees/premiums charged to banks vary based on some assessment of risk?	✓	✓
8.17.2 Were insured depositors wholly compensated (to the extent of legal protection) the last time a bank failed?	✓	✓
8.17.3 Were any deposits not explicitly covered by the deposit insurance scheme at the time of failure compensated the last time a bank failed (excluding funds later paid out in liquidation procedures)?	✓	✓
9.2 Which criteria are taken into account to classify loans and advances as non-performing ...?:	✓	✓
10.5.1 Do banks disclose to the public ...? b. Off-balance sheet items; c. Governance and risk management framework	✓	✓
10.7 Are commercial banks required by supervisors to have external credit ratings?	✓	-
% of (explained) variance - Kaiser criterion	81.20%	77.91%
% of (explained) variance - Scree plot criterion	49.83%	41.81%

Source: Authors' calculations.

distances itself from the other offshore countries, especially on PC2, for topics such as entry into banking licenses (variable 1.3), ownership of voting shares in non-financial firms (variable 4.4.1), NPL classification (variable 9.2), and the preparation of the accounting standards following IFRS (variable 10.2.2).

4.3.3. Robustness on missing data strategy

Section 3.2 dealt with missing values by imputing them to an extra category. Alternative to this active treatment of missing data, many researchers apply a passive strategy, excluding all missing data from the analysis. In our context, the latter strategy implies that countries with missing values on one variable will not contribute to the analysis of that variable. Tables 8 and 9 present the results, which are consistent with those obtained by implementing an active treatment of missing data since most of the variables previously identified as relevant to explain the PC remain determinants for component formation. Nevertheless, reinforcing the theoretical advantages described in Section 3.2 of using an active strategy for dealing with missing data, the NLPCA results based on a passive treatment explain a lower percentage of the total variance (77.91% against the 81.20% in the Kaiser criterion for regulation and 71.52% against 83.57% for supervision).

4.4. Illustration: the impact of the RS components on the probability of banking crises

To illustrate how the PC obtained can be used as measures of banking RS in a regression model, we consider an adaptation of Barth

Table 9

Relevant supervision variables by missing values strategy. Table supporting the robustness checks, confirming the variables that best characterize supervision practices around the world, regardless of the missing values strategy. “✓” refers to relevant variables determining principal components in each strategy.

Variables	Missing values strategy	
	Active treatment	Passive treatment
5.10 Does the banking supervisor have the right to meet with the external auditors and discuss their report without the approval of the bank?	-	✓
5.12 In cases where the supervisor identifies that the bank has received an inadequate audit, does the supervisor have the powers to take actions against ... b. The external auditor	-	✓
10.5 Do banks disclose to the supervisors ...?: b. Off-balance sheet items	✓	✓
11.1 Please indicate whether the following enforcement powers are available to the supervisory agency: a. Cease and desist-type orders for imprudent bank practices; f. Require banks to constitute provisions to cover actual or potential losses; j. Require banks to reduce or suspend dividends to shareholders; k. Require banks to reduce or suspend bonuses and other remuneration to bank directors and managers	✓	✓
11.4 Is there a separate bank insolvency framework that is distinct from that of non-financial firms?	✓	✓
11.5a Which authority has the powers to perform the following problem bank resolution activities? a. Declare insolvency	✓	✓
11.5b. Supersede shareholders' rights	✓	✓
11.5c. Remove and replace bank senior management and directors	✓	✓
11.5e. Appoint and oversee a bank liquidator/receiver	✓	✓
11.6 Is court approval required for the following bank resolution activities? b. Supersede shareholders' rights; c. Remove and replace bank senior management and directors; e. Appoint and oversee a bank liquidator/receiver	✓	✓
11.7 Can the bank shareholders appeal to the court against a resolution decision of the banking supervisor?	✓	-
12.1 What body/agency supervises commercial banks for prudential purposes?	✓	-
12.3.2 Can the supervisory authority force a bank to change its internal organizational structure?	✓	-
12.4 To whom is the supervisory agency legally responsible or accountable?	✓	✓
12.5 How is the head of the supervisory agency appointed?	✓	✓
12.6 Does the head of the supervisory agency have a fixed term?	✓	✓
12.7 Can the head of the supervisory agency be removed by ...	✓	✓
12.9 Can individual supervisory staff be held personally liable for damages to a bank caused by their actions or omissions committed in the good faith exercise of their duties?	✓	-
12.12 If an infraction of any prudential regulation is found in the course of supervision, must it be reported?	✓	-
12.12.1 Are there mandatory actions that the supervisor must take in these cases?	✓	-
% of (explained) variance - Kaiser criterion	83.57%	71.52%
% of (explained) variance - Scree plot criterion	51.82%	38.40%

Source: Authors' calculations.

et al. (2008) on the probability of banking crises. They estimated a logit regression model including as explanatory variables 7 RS indexes constructed with basis on BRSS 2012. Our study restricts the analysis to OECD countries and uses data for 2005–2011 (the midpoint of this period is the beginning of the subprime crisis as a systemic event). We consider two logit models. Model (1) uses an updated version of Barth et al. (2008) indexes for BRSS 2012.¹⁸ Model (2) replaces those indexes with our indicators (four PC for regulation and three for supervision), which, as described before, were constructed using the same BRSS. In both cases, the binary dependent variable (equals one if a country suffers a banking crisis in a given year) was defined according to Laeven and Valencia (2020), and, as in Barth et al. (2008), two macroeconomic variables were included as explanatory variables. Table 10 presents the results.

The results are coherent in both estimations, showing that supervision is not a relevant determinant of banking crises. At the same time, regulation might influence such events, including regulatory practices like deposit insurance—comprised in our PC1 and on the private monitoring index from Barth et al. (2008)—and entry into banking (PC4 and entry into banking requirements index). If we focus on the PC included as explanatory variables, the results suggest that OECD countries with higher scores of PC1 (limitations of the deposit insurance authority power and deposit insurance coverage not defined by the type of banking account and no record of insured deposits as a result of a crisis) and PC4 (limitations on licenses to entry into banking imposed to commercial banks and foreign banks based on reputation) have a lower probability of banking crisis.

The regulatory capital index is irrelevant in Model (1), which also corroborates the low expression of capital requirements in our PC variables. Nevertheless, some differences remain between the two analyses, partially due to the different coverage of the RS variables. For example, PC1 covers a broader range of deposit insurance variables not contained in the private monitoring index. Other differences result from the significance of the variables. In particular, Model (1) suggests that the existence of regulatory restrictions on banking activities (activity restriction index) and the absence of restrictions regarding loans abroad (diversity index) decrease the probability of a banking crisis. At the same time, in Model (2), PC2 and PC3, which comprise similar information, are insignificant.

¹⁸ This updated version was constructed by the same authors and is part of Barth et al. (2013b)'s dataset.

Table 10

Regression results, banking crisis. Table presenting the results of the regression models illustrating the impact of the Regulation and Supervision (RS) components on the probability of banking crises. The binary dependent variable was defined according to [Laeven and Valencia \(2020\)](#). Real GDP growth rate and inflation rate data source is EIU CountryData. RS indexes (Model 1) are from [Barth et al. \(2013b\)](#)'s dataset. PC on RS (Model 2) are those obtained in this paper. P-values are presented in parentheses. Statistical significance is represented as *, ** and ***, representing significance at 10%, 5% and 1% levels, respectively.

Variables	Logit regression	
	Model (1)	Model (2)
Real GDP growth rate	-1.171 (0.000)***	-0.432 (0.000)***
Inflation rate	0.335 (0.120)	0.094 (0.363)
Activity restriction	-1.649 (0.002)***	-
Entry into banking requirements	-3.331 (0.001)***	-
Capital regulatory index	-0.160 (0.594)	-
Private monitoring	2.508 (0.000)***	-
Government-owned banks	-0.210 (0.634)	-
Diversification index	-3.675 (0.009)***	-
Official supervisory power	-0.237 (0.612)	-
Deposit insurance (Regulation PC1)	-	-7.830 (0.003)***
Requirements on banking licensing, liquidity diversification, and credit (Regulation PC2)	-	-1.534 (0.116)
Capital ownership and complementary banking activities (Regulation PC3)	-	-0.201 (0.326)
Entry into banking denied applications and information disclosure (Regulation PC4)	-	1.473 (0.005)***
Supervision institutional structure and mandate (Supervision PC1)	-	0.233 (0.732)
Discipline: enforcement and resolution (Supervision PC2)	-	-1.081 (0.253)
Exit: insolvency (Supervision PC3)	-	-2.507 (0.235)
Constant	24.040 (0.014)**	-5.782 (0.004)***
Number of observations	121	189

5. Conclusion

This paper compiled and summarized the quantitative and qualitative information available on RS for 141 countries. The aim was to determine which banking RS variables are more relevant to distinguish regulatory and supervisory practices worldwide and identify similarities and discrepancies between the observed countries. We showed that using capital requirements as a single proxy for RS, as in many previous studies, is a poor option, given that only one variable related to capital adequacy was relevant to determine the regulation and only for the OECD subsample. In contrast, depositor protection schemes seem to be much more essential in characterizing different banking regulation practices worldwide. Furthermore, supervisory agencies' resolution powers, the characteristics of the mandate of the head of the supervisory agency, and the report of prudential regulation infractions were identified as the most relevant proxies to measure supervision. Our results were robust regardless of countries' development levels or the legal frameworks of each jurisdiction. The findings are potentially helpful for constructing proxies for RS to be used as explanatory variables in future regression analyses.

CRedit authorship contribution statement

Cristina Pereira Pedro: Conceptualization, Methodology, Software, Formal analysis, Investigation, Writing – original draft, Funding acquisition. **Joaquim J.S. Ramalho:** Software, Validation, Formal analysis, Writing – review & editing, Supervision. **Jacinto Vidigal da Silva:** Validation, Writing – review & editing, Supervision.

Declaration of Competing Interest

The author declares that they have no known competing financial interests or personal relationships that would have influenced the

literature and work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A

Table A1

List of countries in the subsamples. West African Economic and Monetary Union (WAEMU) countries (Benin, Burkina Faso, Côte D'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, and Togo) were considered as only one observation given that they have a single supervisory mechanism and responses for all countries are identical.

Non-offshore sample			
Angola	Finland	Malawi	Serbia
Argentina	France	Malaysia	Sierra Leone
Armenia	Gambia	Maldives	Slovakia
Australia	Germany	Mexico	Slovenia
Austria	Ghana	Moldova, Republic of	South Africa
Bangladesh	Greece	Montenegro	Spain
Belarus	Guatemala	Morocco	Sri Lanka
Belgium	Guyana	Mozambique	Suriname
Benin	Honduras	Myanmar	Swaziland
Bhutan	Hungary	Namibia	Syrian Arab republic
Bosnia and Herzegovina	Iceland	Nepal	Taiwan
Botswana	India	Netherlands	Tajikistan
Brazil	Indonesia	New Zealand	Tanzania, United Republic of
Bulgaria	Iraq	Nicaragua	Thailand
Burundi	Ireland	Nigeria	Tonga
Canada	Israel	Norway	Trinidad and Tobago
Chile	Italy	Oman	Tunisia
China-people's Rep.	Jamaica	Pakistan	Turkey
Colombia	Jordan	Palestinian Territory	Uganda
Croatia	Kenya	Paraguay	Ukraine
Denmark	Korea, Republic of	Peru	United Arab Emirates
Dominican Republic	Kosovo	Philippines	United Kingdom
Ecuador	Kuwait	Poland	United States
Egypt	Kyrgyzstan	Portugal	Uruguay
El Salvador	Latvia	Puerto Rico	Venezuela, Bolivarian Rep. of
Estonia	Lesotho	Qatar	Yemen
Ethiopia	Lithuania	Romania	Zimbabwe
Fiji	Madagascar	Russian Federation	
Offshore sample			
Bahrain	Gibraltar	Liechtenstein	Samoa
Belize	Guernsey	Luxembourg	Seychelles
Cayman Islands	Hong Kong	Macao	Switzerland
Cook Islands	Isle of Man	Malta	Vanuatu
Costa Rica	Jersey	Mauritius	Virgin Islands, British
Cyprus	Lebanon	Panama	
OECD sample			
Australia	France	Korea, Republic of	Slovakia
Austria	Germany	Luxembourg	Slovenia
Belgium	Greece	Mexico	Spain
Canada	Hungary	Netherlands	Switzerland
Chile	Iceland	New Zealand	Turkey
Denmark	Ireland	Norway	United Kingdom
Estonia	Israel	Poland	United States
Finland	Italy	Portugal	

Table A2

CATPCA results: component loadings for regulation PC. Bold values in light shading represent component loadings (correlations between variables and components) above 0.5.

Variables	Kaiser criterion															Scree plot method			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	1	2	3	4
Q.1.1	-0.131	0.236	-0.102	-0.209	0.035	-0.241	-0.070	0.179	-0.384	0.068	0.525	-0.313	0.058	-0.109	-0.144	-0.080	0.556	-0.021	-0.012
Q.1.3	0.018	-0.202	0.059	-0.108	0.154	-0.078	-0.099	0.036	0.229	0.615	0.190	0.157	-0.111	0.085	0.069	0.029	-0.217	0.068	0.076
Q.1.4.1	0.024	0.021	-0.085	0.021	0.069	-0.158	-0.126	0.364	0.254	0.293	-0.163	0.425	-0.141	-0.355	0.128	0.022	0.042	-0.093	-0.115
Q.1.4.2	0.218	0.683	-0.145	-0.016	-0.013	-0.085	-0.249	-0.047	0.035	-0.117	0.174	-0.009	0.199	-0.210	-0.016	0.225	0.684	-0.108	0.040
Q.1.4.3	0.254	-0.027	-0.130	0.215	0.129	0.211	-0.351	0.056	0.362	0.082	-0.083	-0.017	0.217	-0.018	-0.240	0.267	-0.038	-0.138	0.123
Q.1.5	0.162	0.056	0.135	-0.052	-0.009	0.351	-0.375	0.212	0.059	-0.292	0.171	-0.216	-0.154	-0.053	0.305	0.172	0.044	0.132	0.174
Q.1.6	0.009	-0.205	0.271	0.253	-0.021	0.098	0.310	0.595	-0.253	-0.056	0.017	0.091	0.008	-0.356	0.157	0.115	0.718	-0.092	-0.012
Q.1.8	0.137	0.167	0.075	0.365	0.191	0.412	0.526	0.310	-0.066	0.129	-0.101	-0.074	0.194	-0.028	-0.176	-0.297	0.102	-0.067	0.329
Q.1.13	-0.061	0.069	0.062	0.373	0.555	-0.574	-0.114	0.082	-0.017	0.181	-0.036	-0.117	-0.089	-0.006	0.031	0.196	-0.076	-0.019	0.619
Q.2.5.1	-0.101	0.128	0.786	-0.076	-0.022	-0.027	0.001	0.092	-0.141	0.101	0.027	-0.014	0.021	-0.344	0.174	-0.106	0.104	0.766	0.015
Q.2.6	0.179	0.402	0.428	0.304	0.257	-0.104	0.063	0.350	0.145	-0.183	0.028	0.162	-0.132	0.250	-0.160	0.178	0.384	0.431	-0.069
Q.2.7	0.148	0.459	0.442	0.155	0.110	0.080	0.099	0.372	0.135	-0.254	0.133	0.115	-0.103	0.256	-0.222	0.152	0.432	0.465	-0.027
Q.3.1	-0.268	-0.055	0.101	0.165	-0.608	-0.412	0.296	0.029	-0.031	-0.161	-0.033	0.012	0.178	0.154	0.061	-0.309	-0.039	0.101	-0.661
Q.3.2	-0.230	-0.002	0.031	0.105	-0.650	-0.461	0.082	0.093	0.190	-0.064	-0.010	-0.133	0.053	-0.086	0.062	-0.266	0.054	0.043	-0.717
Q.3.18	0.077	0.060	0.031	-0.231	-0.253	0.461	-0.248	0.325	0.093	0.100	-0.136	-0.129	-0.095	0.213	0.178	0.119	-0.015	0.053	0.285
Q.4.1	-0.065	0.194	0.924	-0.152	-0.002	-0.008	-0.056	-0.193	0.084	0.072	0.003	-0.021	0.078	0.015	0.013	-0.057	0.132	0.952	0.090
Q.4.2	-0.079	0.192	0.920	-0.156	-0.006	-0.020	-0.033	-0.194	0.089	0.078	-0.008	-0.030	0.089	0.019	0.012	-0.099	0.134	0.943	0.074
Q.4.3	-0.087	0.182	0.922	-0.157	-0.005	-0.021	-0.044	-0.194	0.085	0.081	-0.014	-0.033	0.074	0.014	0.015	-0.100	0.129	0.943	0.073
Q.4.4.1	-0.135	-0.079	-0.144	-0.068	-0.062	-0.070	0.189	0.009	0.582	0.129	0.368	-0.390	-0.087	-0.206	-0.166	-0.130	0.134	0.089	-0.461
Q.5.1.1	-0.024	0.006	0.028	0.392	0.310	-0.096	-0.282	-0.049	0.137	-0.074	-0.373	-0.378	-0.041	0.100	0.243	0.115	0.049	0.046	-0.038
Q.5.1.2	-0.089	-0.020	-0.077	-0.481	0.319	-0.096	0.263	0.170	0.247	-0.159	-0.162	-0.126	0.147	-0.074	0.284	-0.101	-0.022	-0.040	0.289
Q.7.2	0.232	0.892	-0.174	-0.053	-0.073	-0.125	-0.105	-0.036	0.079	-0.120	-0.025	0.094	-0.048	-0.108	-0.042	0.233	0.910	-0.119	-0.032
Q.7.2.2	0.235	0.893	-0.172	-0.046	-0.073	-0.120	-0.105	-0.032	0.083	-0.116	-0.022	0.093	-0.048	-0.112	-0.040	0.239	0.910	-0.122	-0.027
Q.7.4	0.082	0.675	-0.172	-0.091	-0.090	-0.165	0.087	-0.008	-0.236	0.191	-0.005	0.002	-0.036	0.228	0.391	0.070	0.678	-0.128	-0.066
Q.7.4.1	0.052	0.704	-0.180	0.035	0.070	0.113	0.260	-0.061	-0.199	0.361	-0.036	-0.071	0.043	0.170	0.304	0.046	0.678	-0.156	0.098
Q.8.1	0.869	-0.073	0.047	-0.077	0.012	0.024	0.058	-0.045	-0.083	-0.044	-0.076	0.070	-0.126	0.059	-0.051	0.861	-0.061	0.058	0.007
Q.8.2.1	0.275	0.066	0.091	-0.163	0.163	0.099	-0.098	0.167	-0.305	0.030	0.165	-0.422	-0.237	-0.078	-0.119	0.280	0.052	0.113	0.184
Q.8.4	0.923	-0.095	0.037	-0.003	-0.101	-0.029	0.116	-0.085	0.006	-0.018	-0.054	0.005	-0.036	-0.008	0.022	0.921	-0.086	0.043	-0.074
Q.8.4.1	0.925	-0.084	0.052	-0.018	-0.047	-0.030	0.067	-0.027	-0.025	0.001	-0.121	-0.033	-0.127	0.044	-0.053	0.921	-0.078	0.058	-0.077
Q.8.4.2	0.925	-0.076	0.054	-0.016	-0.082	-0.021	0.131	-0.054	-0.039	-0.037	-0.107	-0.042	-0.117	0.023	-0.061	0.919	-0.068	0.063	-0.086
Q.8.4.3	0.870	-0.070	0.057	0.021	0.069	-0.146	0.053	0.034	-0.049	-0.039	-0.079	-0.074	-0.174	0.085	-0.131	0.866	-0.055	0.074	-0.095
Q.8.5	0.942	-0.095	0.033	-0.052	-0.060	-0.038	0.071	-0.071	-0.040	0.025	-0.070	0.025	-0.020	-0.056	-0.028	0.939	-0.089	0.046	-0.049
Q.8.6	0.943	-0.083	0.069	-0.023	-0.102	-0.073	0.065	-0.001	-0.081	0.011	-0.029	-0.019	0.008	-0.140	0.032	0.940	-0.070	0.069	-0.107
Q.8.7	0.939	-0.081	0.030	0.005	-0.085	-0.044	-0.013	-0.062	-0.024	-0.018	-0.092	-0.071	0.029	-0.024	0.016	0.937	-0.076	0.025	-0.102
Q.8.10	0.904	-0.087	0.016	-0.013	-0.038	0.033	0.016	-0.104	0.052	0.001	0.019	-0.009	0.025	-0.109	0.042	0.907	-0.083	0.022	0.031
Q.8.12	0.907	-0.058	0.015	-0.035	-0.004	-0.077	-0.007	-0.017	0.003	0.027	0.024	-0.037	-0.011	-0.046	0.006	0.906	-0.051	0.018	-0.051
Q.8.13	0.894	-0.089	0.017	0.062	0.080	-0.111	-0.097	-0.036	0.030	0.052	-0.029	-0.060	0.010	-0.079	0.055	0.895	-0.081	0.009	-0.043
Q.8.14	0.928	-0.089	0.015	-0.030	-0.052	-0.045	-0.031	-0.030	0.011	0.055	0.027	-0.022	0.054	-0.112	0.013	0.927	-0.085	0.021	-0.043
Q.8.17.2	0.670	-0.036	-0.058	-0.012	0.004	0.017	0.109	0.163	0.234	0.072	0.347	-0.016	0.293	0.272	0.155	0.672	-0.048	-0.042	0.004
Q.8.17.3	0.702	-0.072	-0.025	0.095	-0.069	-0.181	-0.021	0.181	0.167	0.050	0.316	0.028	0.218	0.297	0.155	0.706	-0.069	-0.016	-0.177
Q.9.1	-0.097	-0.019	0.013	0.448	0.466	-0.489	0.101	-0.247	-0.021	-0.047	0.115	-0.004	-0.197	-0.022	0.090	-0.221	0.034	-0.079	-0.220
Q.9.2	0.233	0.900	-0.178	-0.097	-0.140	0.017	-0.046	-0.024	0.102	-0.077	-0.038	0.093	-0.021	-0.126	-0.050	0.240	0.922	-0.170	0.036
Q.9.5	-0.010	-0.086	0.045	-0.367	0.186	0.056	0.337	-0.307	-0.028	0.077	0.219	0.245	-0.043	0.000	-0.122	0.037	-0.068	0.088	0.385
Q.10.1	-0.025	-0.041	-0.072	-0.478	0.358	-0.150	0.301	0.018	0.235	-0.288	-0.206	-0.116	0.247	-0.123	0.097	-0.028	-0.033	-0.027	0.268
Q.10.2.1	0.046	-0.116	0.030	-0.366	-0.142	-0.512	-0.366	0.328	-0.152	-0.002	-0.024	0.218	-0.011	0.080	-0.112	-0.004	-0.068	0.074	-0.446
Q.10.2.2	0.059	0.063	0.170	0.582	-0.315	0.303	-0.210	-0.244	-0.046	0.062	0.062	0.004	0.090	-0.091	0.016	0.303	-0.066	-0.117	-0.400
Q.10.2.4	0.169	-0.048	0.012	0.225	0.325	-0.104	-0.211	-0.069	-0.247	-0.204	0.057	0.084	0.598	-0.021	-0.014	0.180	-0.075	-0.011	0.185

(continued on next page)

Table A2 (continued)

Variables	Kaiser criterion															Scree plot method			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	1	2	3	4
Q.10.2.5	0.291	-0.275	-0.064	0.380	-0.052	0.133	-0.058	-0.012	0.056	0.066	0.229	0.154	0.161	-0.191	0.202	0.299	-0.299	-0.117	-0.004
Q.10.5.1	0.297	-0.157	-0.055	-0.368	0.431	0.266	-0.206	-0.047	-0.097	-0.187	0.196	0.280	0.031	0.037	0.125	0.269	-0.146	-0.064	0.634
Q.10.5.2	-0.066	-0.015	0.023	0.271	0.000	0.118	0.198	-0.251	0.151	-0.410	0.357	0.167	-0.382	-0.044	0.301	0.109	-0.082	-0.040	0.285
Q.10.7	0.150	0.787	-0.173	0.098	0.151	0.252	0.205	-0.104	0.043	0.188	-0.050	-0.037	0.072	-0.097	-0.090	0.143	0.771	-0.150	0.198
Q.1.7a.*	-0.031	0.419	0.219	0.047	0.029	0.115	0.052	-0.208	-0.078	0.034	-0.093	-0.078	0.025	-0.085	-0.039	-0.025	0.399	0.233	0.064
Q.1.7b.*	-0.020	0.420	0.221	0.035	0.040	0.111	0.045	-0.199	-0.072	0.058	-0.094	-0.075	0.035	-0.083	-0.043	-0.019	0.398	0.233	0.068
Q.1.10a.*	-0.016	0.377	0.246	0.154	0.072	0.151	0.145	0.078	-0.058	-0.090	-0.192	-0.045	-0.032	0.036	-0.110	-0.019	0.353	0.250	-0.009
Q.1.10b.*	0.017	0.326	0.232	0.226	0.240	0.053	0.078	0.052	-0.091	-0.059	-0.161	-0.091	-0.035	0.039	-0.098	0.020	0.309	0.229	0.045
Q.1.10c.*	-0.010	0.350	0.242	0.235	0.245	0.023	0.082	0.090	-0.063	-0.029	-0.178	-0.045	-0.052	0.045	-0.092	-0.022	0.332	0.233	0.022
Q.1.11a.*	0.025	0.331	0.229	0.175	0.030	0.165	0.147	0.022	-0.089	-0.108	-0.182	-0.184	-0.041	-0.026	-0.150	-0.023	-0.342	-0.247	0.011
Q.1.11b.*	0.035	0.315	0.228	0.239	0.251	0.054	0.050	0.046	-0.080	-0.032	-0.158	-0.099	-0.030	-0.015	-0.136	0.015	0.309	0.227	0.054
Q.1.11c.*	-0.034	0.340	0.231	0.272	0.221	0.048	0.074	0.049	-0.088	-0.051	-0.168	-0.106	-0.049	-0.027	-0.124	-0.028	0.330	0.230	0.034
Q.1.12a.*	-0.105	-0.278	-0.268	-0.207	-0.095	-0.130	-0.162	-0.021	0.174	0.128	0.073	-0.027	0.041	0.136	-0.026	-0.097	-0.259	-0.246	-0.001
Q.1.12b.*	0.094	0.263	0.266	0.300	0.228	0.025	0.107	0.011	-0.188	-0.100	-0.060	0.009	-0.031	-0.151	0.021	-0.087	-0.247	-0.239	-0.039
Q.1.12c.*	0.057	0.281	0.271	0.315	0.211	0.018	0.122	0.025	-0.182	-0.099	-0.083	0.009	-0.062	-0.156	0.020	0.050	0.266	0.242	0.013
Q.2.3.1*	-0.079	0.017	-0.037	-0.258	-0.180	-0.055	0.033	-0.157	-0.057	0.037	-0.143	-0.154	-0.119	-0.151	-0.078	-0.099	0.054	-0.019	-0.073
Q.2.5.2*	-0.180	-0.053	-0.299	-0.179	-0.179	-0.037	-0.069	-0.102	-0.013	-0.198	0.025	0.005	0.056	0.224	-0.003	-0.232	-0.093	-0.232	-0.101
Q.2.6.1*	0.131	0.115	0.112	0.005	0.187	-0.111	0.197	0.048	0.128	-0.095	0.113	0.018	-0.006	-0.072	0.154	0.115	0.129	0.143	-0.001
Q.3.3.1*	0.159	-0.139	-0.059	-0.031	0.127	0.160	-0.163	0.036	0.116	0.040	-0.160	-0.074	-0.028	-0.008	0.030	0.168	-0.157	-0.063	0.150
Q.3.4.1*	0.104	0.022	-0.015	0.185	0.132	0.268	-0.010	-0.020	0.133	0.034	0.130	0.015	0.263	0.042	-0.076	0.194	-0.118	-0.036	0.169
Q.3.18.2*	-0.074	0.060	0.036	-0.074	-0.047	-0.099	0.145	0.048	0.105	-0.156	0.110	0.073	-0.078	-0.070	0.017	-0.083	0.014	-0.074	0.088
Q.8.11*	-0.603	-0.021	-0.152	-0.101	-0.137	-0.008	-0.048	0.008	-0.063	-0.104	0.053	-0.017	-0.139	0.004	-0.204	-0.603	-0.009	-0.133	-0.039
Q.8.11.1*	0.495	-0.002	0.152	0.140	0.045	0.025	0.084	-0.087	-0.047	-0.072	0.045	-0.062	-0.063	0.023	0.093	-0.494	0.004	-0.133	0.039
Q.8.13.1*	0.490	-0.054	-0.065	0.033	0.080	-0.028	0.004	-0.019	-0.035	0.215	0.001	-0.031	-0.005	-0.073	0.001	0.489	-0.045	-0.078	0.076
Q.8.17.1*	-0.466	0.000	-0.080	-0.001	-0.098	0.021	0.011	-0.129	-0.086	-0.174	-0.046	0.001	-0.218	-0.144	-0.250	0.464	-0.015	0.080	0.048
Q.9.1.3a.*	0.273	-0.195	-0.041	0.043	0.130	0.242	-0.036	0.165	0.172	-0.051	-0.037	-0.020	0.128	0.009	-0.059	0.287	-0.219	-0.052	0.233
Q.9.1.3b.*	0.274	-0.192	-0.041	0.118	0.160	0.262	-0.081	0.154	0.206	-0.038	-0.029	-0.008	0.123	-0.021	-0.013	0.284	-0.221	-0.052	0.242
Q.9.1.3c.*	0.320	-0.153	-0.017	0.128	0.231	0.280	-0.070	0.100	0.100	-0.008	-0.069	0.005	0.056	-0.098	-0.017	0.335	-0.170	-0.036	0.263
Q.9.6.3a.*	0.227	-0.217	-0.004	0.188	0.031	0.171	-0.293	0.146	0.086	-0.053	-0.041	0.134	0.003	-0.062	-0.060	0.298	-0.207	-0.011	0.040
Q.9.6.3b.*	0.298	-0.190	-0.040	0.211	0.136	0.275	-0.240	0.050	0.119	-0.037	-0.049	0.105	-0.006	0.048	-0.108	0.330	-0.196	-0.047	0.145
Q.9.6.3c.*	0.297	-0.198	-0.008	0.244	0.106	0.266	-0.224	0.108	0.103	-0.021	-0.059	0.119	0.017	-0.063	-0.048	0.336	-0.212	-0.030	0.133
Q.10.8*	-0.127	-0.200	0.069	-0.178	-0.429	-0.163	0.062	0.100	-0.044	0.131	-0.051	0.006	0.110	-0.031	0.040	-0.368	0.024	0.116	-0.175
Q.10.9*	-0.065	0.220	-0.060	0.138	0.124	0.159	0.077	-0.018	0.116	-0.198	-0.019	0.047	-0.031	0.029	0.032	-0.116	0.195	-0.054	0.080
Q.13.7.1*	-0.155	-0.257	0.064	-0.249	-0.019	-0.156	-0.033	-0.072	-0.151	-0.052	-0.080	-0.088	-0.344	0.104	-0.015	-0.159	-0.237	0.081	-0.061
Q.13.7.2*	-0.039	-0.250	0.095	-0.156	0.022	-0.084	-0.019	0.091	-0.110	-0.064	-0.091	-0.040	-0.260	0.069	0.005	-0.025	-0.237	0.075	-0.057

* Supplementary variable

Source: Authors' calculations

Table A3

Object scores of each country by PC and regulation. Sorted list of countries in ascending order of object scores by PC. The object scores are the coordinates of each country in each PC.

Country	PC 1	Country	PC 2	Country	PC 3	Country	PC 4
Germany	-1.100	Burundi	-0.770	China	-1.396	Myanmar	-3.557
Denmark	-0.989	Fiji	-0.654	Myanmar	-1.023	Burundi	-3.503
Portugal	-0.941	New Zealand	-0.592	Liechtenstein	-0.665	Tajikistan	-3.354
Romania	-0.907	Panama	-0.588	Finland	-0.481	Yemen	-3.149
Slovakia	-0.900	Cayman Islands	-0.571	Lebanon	-0.477	Guatemala	-2.475
Hungary	-0.888	Seychelles	-0.559	Uganda	-0.414	Bosnia and Herzegovina	-1.964
Norway	-0.881	Maldives	-0.554	Tunisia	-0.395	Fiji	-1.765
Iceland	-0.878	United Arab Emirates	-0.553	Denmark	-0.391	Angola	-1.704
Isle of Man	-0.877	Belize	-0.547	Portugal	-0.373	Iraq	-1.659
Spain	-0.861	Syrian Arab Republic	-0.546	Armenia	-0.365	Puerto Rico	-1.554
Canada	-0.860	Madagascar	-0.542	Oman	-0.354	Paraguay	-1.415
Latvia	-0.834	Kuwait	-0.535	Cyprus	-0.349	Sierra Leone	-1.303
Lithuania	-0.832	Gambia	-0.531	Ireland	-0.348	Venezuela	-1.300
Luxembourg	-0.816	Bhutan	-0.530	Moldova	-0.346	Virgin Islands, British	-1.162
United States	-0.811	Guyana	-0.528	Slovakia	-0.338	El Salvador	-1.139
Mexico	-0.809	Malawi	-0.526	Mozambique	-0.337	Tunisia	-1.018
Italy	-0.807	Tonga	-0.525	Bahrain	-0.334	Ethiopia	-0.980
Belgium	-0.806	Vanuatu	-0.523	Guatemala	-0.328	Panama	-0.898
Finland	-0.806	Suriname	-0.516	Swaziland	-0.298	Suriname	-0.873
Bulgaria	-0.801	South Africa	-0.500	El Salvador	-0.298	Kyrgyzstan	-0.827
Netherlands	-0.795	Botswana	-0.480	Macao	-0.297	Germany	-0.798
Greece	-0.792	Palestinian Territory	-0.479	Kosovo	-0.247	Honduras	-0.772
United Kingdom	-0.785	Egypt	-0.476	Greece	-0.247	Kosovo	-0.749
Peru	-0.777	Guatemala	-0.451	Estonia	-0.246	Guernsey	-0.740
Slovenia	-0.771	Pakistan	-0.448	Trinidad and Tobago	-0.244	Madagascar	-0.723
Taiwan	-0.769	Samoa	-0.433	Montenegro	-0.243	Dominican Republic	-0.705
Australia	-0.759	Mauritius	-0.423	Switzerland	-0.242	Belize	-0.616
Brazil	-0.748	Costa Rica	-0.421	Ukraine	-0.233	Gambia	-0.585
Uruguay	-0.748	Ghana	-0.413	Hungary	-0.233	Switzerland	-0.584
Zimbabwe	-0.742	Israel	-0.344	Kenya	-0.231	Indonesia	-0.563
Austria	-0.741	WAEMU countries	-0.290	Jamaica	-0.230	Vanuatu	-0.552
Ireland	-0.735	Iraq	-0.286	Belgium	-0.225	Lesotho	-0.479
Puerto Rico	-0.722	Jersey	-0.282	Ethiopia	-0.223	Swaziland	-0.469
Russia	-0.719	Macao	-0.259	Sri Lanka	-0.223	Mozambique	-0.413
Lebanon	-0.710	Montenegro	-0.255	Poland	-0.221	Macao	-0.383
India	-0.707	Sierra Leone	-0.253	Chile	-0.220	Samoa	-0.355
Poland	-0.706	Yemen	-0.252	Tajikistan	-0.219	Nigeria	-0.342
Kenya	-0.704	Kosovo	-0.247	Bulgaria	-0.219	Colombia	-0.316
Bosnia and Herzegovina	-0.700	Namibia	-0.232	Tanzania	-0.218	Argentina	-0.306
Tajikistan	-0.695	Lebanon	-0.228	Yemen	-0.216	Moldova	-0.298
Belarus	-0.685	Swaziland	-0.214	Colombia	-0.214	Trinidad and Tobago	-0.286
Jamaica	-0.681	Nigeria	-0.214	Gibraltar	-0.209	Bhutan	-0.280
Ukraine	-0.679	Uruguay	-0.198	Malta	-0.207	Nicaragua	-0.275
El Salvador	-0.673	Dominican Republic	-0.192	Venezuela	-0.207	Ecuador	-0.246
Argentina	-0.663	El Salvador	-0.191	Bosnia and Herzegovina	-0.206	Maldives	-0.246
Switzerland	-0.662	Venezuela	-0.185	Virgin Islands, British	-0.198	Kenya	-0.238
Serbia	-0.652	Trinidad and Tobago	-0.179	Jersey	-0.192	United States	-0.191
Moldova	-0.642	Chile	-0.172	Brazil	-0.191	Seychelles	-0.159
Uganda	-0.642	Uganda	-0.171	Burundi	-0.188	Ukraine	-0.149
Philippines	-0.641	Oman	-0.171	Latvia	-0.186	Tonga	-0.137
Mozambique	-0.632	Guernsey	-0.171	Morocco	-0.184	France	-0.122
Dominican Republic	-0.628	Bahrain	-0.166	Uruguay	-0.183	Tanzania	-0.073
Hong Kong	-0.623	Cyprus	-0.162	Taiwan	-0.178	Uganda	-0.045
Korea	-0.621	Armenia	-0.161	Sierra Leone	-0.175	Egypt	-0.024
Trinidad and Tobago	-0.619	Slovakia	-0.160	Guernsey	-0.173	Morocco	-0.017
Turkey	-0.614	Virgin Islands, British	-0.153	Norway	-0.164	Guyana	-0.012
Gibraltar	-0.606	Hong Kong	-0.152	Serbia	-0.157	Malawi	-0.001
Estonia	-0.602	Tajikistan	-0.151	Spain	-0.155	Brazil	0.022
Morocco	-0.595	Moldova	-0.149	Honduras	-0.154	Montenegro	0.073
Colombia	-0.592	Ethiopia	-0.148	Argentina	-0.152	Austria	0.075
Guernsey	-0.585	Sri Lanka	-0.147	Canada	-0.151	Isle of Man	0.086
Indonesia	-0.583	Serbia	-0.137	Nigeria	-0.150	Belarus	0.096
Paraguay	-0.581	Ireland	-0.126	Iceland	-0.150	Norway	0.098
France	-0.574	Estonia	-0.124	Kyrgyzstan	-0.141	Taiwan	0.104
Cyprus	-0.570	Kyrgyzstan	-0.118	Peru	-0.139	WAEMU countries	0.106
Croatia	-0.567	Cook Islands	-0.118	Belarus	-0.134	Serbia	0.116

(continued on next page)

Table A3 (continued)

Country	PC 1	Country	PC 2	Country	PC 3	Country	PC 4
Armenia	-0.560	Greece	-0.116	Philippines	-0.133	Uruguay	0.143
Bahrain	-0.533	Kenya	-0.116	Lithuania	-0.130	United Kingdom	0.162
Malaysia	-0.520	Mexico	-0.112	Indonesia	-0.126	Finland	0.181
Malta	-0.520	Portugal	-0.111	Dominican Republic	-0.120	Mexico	0.186
Venezuela	-0.505	Peru	-0.105	Russia	-0.118	Jersey	0.195
Jersey	-0.501	Malta	-0.102	Romania	-0.116	Spain	0.201
Sri Lanka	-0.481	Mozambique	-0.094	Samoa	-0.107	Belgium	0.205
Tanzania	-0.477	Croatia	-0.091	Croatia	-0.095	Thailand	0.206
Nicaragua	-0.471	Bosnia and Herzegovina	-0.087	Paraguay	-0.094	Malaysia	0.262
Liechtenstein	-0.471	Indonesia	-0.085	Isle of Man	-0.093	Peru	0.271
Jordan	-0.459	Nepal	-0.073	Guyana	-0.091	Chile	0.292
Oman	-0.457	Spain	-0.066	Suriname	-0.090	Lebanon	0.295
Thailand	-0.442	Zimbabwe	-0.066	Luxembourg	-0.081	Australia	0.313
Guatemala	-0.380	Belgium	-0.065	Italy	-0.080	Jamaica	0.319
Bangladesh	-0.329	Tanzania	-0.065	Puerto Rico	-0.076	Cayman Islands	0.343
Honduras	-0.328	Argentina	-0.057	United Kingdom	-0.068	China	0.352
Myanmar	-0.320	France	-0.057	Slovenia	-0.067	Romania	0.370
Virgin Islands	-0.297	India	-0.056	India	-0.065	Greece	0.394
Nigeria	-0.269	Paraguay	-0.052	Nicaragua	-0.063	Costa Rica	0.418
Ethiopia	-0.210	Morocco	-0.051	Vanuatu	-0.057	Slovenia	0.429
Montenegro	-0.208	Taiwan	-0.051	Netherlands	-0.056	Turkey	0.434
Ecuador	-0.134	Honduras	-0.046	France	-0.052	Portugal	0.438
Kyrgyzstan	-0.117	Belarus	-0.044	Belize	-0.048	Lithuania	0.490
Yemen	-0.112	United States	-0.027	Cayman Islands	-0.043	Bangladesh	0.492
Sierra Leone	-0.108	Romania	-0.024	United States	-0.042	Bulgaria	0.496
Chile	-0.031	Isle of Man	-0.006	Austria	-0.039	Palestinian Territory	0.521
Iraq	-0.013	Nicaragua	-0.005	Gambia	-0.037	Philippines	0.525
Lesotho	0.005	Lithuania	0.000	Hong Kong	-0.036	India	0.543
Swaziland	0.033	Russia	0.006	Tonga	-0.032	Oman	0.548
Kosovo	0.198	Malaysia	0.007	Australia	-0.022	Hong Kong	0.548
Angola	0.214	Brazil	0.009	Bhutan	-0.022	Korea	0.561
Macao	0.335	Bulgaria	0.010	Malaysia	-0.016	Croatia	0.562
Namibia	0.824	Turkey	0.013	Fiji	-0.014	Malta	0.562
Tunisia	0.915	Italy	0.018	Turkey	-0.009	Zimbabwe	0.562
Samoa	0.950	Netherlands	0.022	Madagascar	-0.002	Hungary	0.592
Costa Rica	1.036	Austria	0.023	Seychelles	0.016	Cook Islands	0.599
Mauritius	1.413	Norway	0.026	Mexico	0.020	Netherlands	0.612
Maldives	1.420	Philippines	0.032	New Zealand	0.021	Israel	0.654
New Zealand	1.463	Gibraltar	0.033	Maldives	0.024	South Africa	0.687
Seychelles	1.502	Iceland	0.066	Iraq	0.026	Italy	0.688
Syrian Arab Republic	1.511	Jamaica	0.100	Panama	0.061	Bahrain	0.706
Kuwait	1.520	Canada	0.105	Zimbabwe	0.062	Sri Lanka	0.749
Tonga	1.520	Ecuador	0.107	Syrian Arab Republic	0.074	Liechtenstein	0.767
South Africa	1.529	Switzerland	0.113	Palestinian Territory	0.077	Iceland	0.798
WAEMU countries	1.542	Jordan	0.117	Malawi	0.083	Canada	0.820
Pakistan	1.556	Ukraine	0.120	Botswana	0.090	Jordan	0.861
Israel	1.563	Latvia	0.129	Ecuador	0.099	Russia	0.865
Ghana	1.564	Denmark	0.137	Pakistan	0.100	Botswana	0.873
Cook Islands	1.585	Luxembourg	0.153	Egypt	0.101	Ireland	0.878
Cayman Islands	1.585	Slovenia	0.159	Kuwait	0.105	Luxembourg	0.911
Botswana	1.617	Hungary	0.169	Ghana	0.117	Estonia	0.933
Qatar	1.624	Korea	0.189	Jordan	0.137	Ghana	0.933
Suriname	1.629	Poland	0.200	United Arab Emirates	0.143	Cyprus	0.972
Palestinian Territory	1.629	Thailand	0.239	Israel	0.154	New Zealand	0.976
Guyana	1.640	Qatar	0.280	Costa Rica	0.166	Pakistan	0.984
Egypt	1.660	Lesotho	0.373	Mauritius	0.184	Latvia	1.018
Bhutan	1.662	Angola	0.443	WAEMU countries	0.197	Armenia	1.023
Gambia	1.682	Bangladesh	0.462	Namibia	0.271	Gibraltar	1.036
Malawi	1.687	Australia	0.547	South Africa	0.295	Mauritius	1.108
Vanuatu	1.717	Puerto Rico	0.561	Thailand	0.446	Namibia	1.204
Belize	1.728	Tunisia	0.617	Cook Islands	0.585	Slovakia	1.254
Panama	1.741	United Kingdom	0.622	Bangladesh	0.721	Poland	1.281
United Arab Emirates	1.748	Colombia	1.053	Lesotho	0.885	Qatar	1.310
Madagascar	1.767	Liechtenstein	1.414	Qatar	0.954	Syrian Arab Republic	1.507
Fiji	1.782	Germany	1.497	Angola	1.008	United Arab Emirates	1.512
Nepal	1.917	Finland	1.530	Nepal	1.207	Kuwait	1.816
Burundi	2.003	Myanmar	2.009	Korea	1.577	Nepal	1.880
China	2.677	China	10.496	Germany	10.863	Denmark	2.446

Source: Authors' calculations

Table A4

CATPCA results: component loadings for supervision PC. Bold values in light shading represent component loadings (correlations between variables and components) above 0.5.

Variables	Principal components Kaiser criterion									Scree plot method		
	1	2	3	4	5	6	7	8	9	1	2	3
Q.5.9	-0.038	-0.040	0.171	0.054	-0.003	-0.087	0.723	-0.207	-0.145	-0.034	0.014	0.071
Q.5.10	-0.022	0.123	0.050	-0.090	-0.197	-0.275	-0.373	0.717	-0.122	0.168	0.163	0.067
Q.5.12	0.115	0.008	0.193	0.259	-0.274	0.700	-0.032	0.247	0.181	0.188	-0.057	-0.173
Q.10.5	0.073	-0.025	0.136	0.177	-0.125	0.713	0.349	0.142	-0.142	0.045	-0.071	0.034
Q.11.1	-0.020	-0.990	0.046	0.072	-0.062	-0.048	-0.032	0.019	-0.042	0.220	0.686	-0.268
Q.11.1.1	0.120	0.034	0.320	0.076	-0.291	-0.395	0.513	0.219	0.464	-0.284	-0.256	-0.014
Q.11.3	0.019	0.036	0.225	0.719	0.642	-0.091	-0.033	0.091	0.016	-0.100	-0.012	-0.013
Q.11.4	0.205	0.214	0.126	0.331	-0.338	-0.177	0.146	0.078	-0.581	0.072	0.282	0.631
Q.11.5a	0.027	0.990	-0.051	-0.068	0.061	0.048	0.029	-0.024	0.052	0.318	0.823	-0.317
Q.11.5b	-0.014	-0.005	0.596	0.285	-0.425	-0.044	-0.346	-0.377	0.070	0.207	0.776	-0.226
Q.11.5c	0.019	0.036	0.232	0.717	0.642	-0.087	-0.034	0.089	0.017	0.198	0.793	-0.261
Q.11.5e	0.024	0.991	-0.045	-0.064	0.054	0.047	0.027	-0.023	0.036	0.049	0.285	0.885
Q.11.6	-0.010	0.217	0.590	0.281	-0.431	-0.095	-0.309	-0.270	-0.041	0.068	0.321	0.811
Q.11.7	0.042	-0.024	-0.481	0.375	-0.190	0.035	-0.195	-0.025	0.490	-0.050	-0.314	-0.870
Q.12.1	0.755	-0.037	0.157	0.037	-0.061	0.503	-0.014	0.150	0.029	0.707	-0.263	0.075
Q.12.3.2	0.941	-0.042	0.003	-0.118	0.127	-0.001	-0.045	-0.104	-0.053	0.904	-0.290	0.056
Q.12.4	-0.105	-0.003	0.653	-0.536	0.364	0.111	-0.088	-0.011	0.150	0.589	-0.227	0.108
Q.12.5	0.943	-0.024	0.008	-0.132	0.116	0.006	-0.057	-0.116	-0.050	0.910	-0.279	0.048
Q.12.6	0.766	-0.005	-0.159	-0.039	0.109	0.007	-0.055	-0.198	0.147	0.860	0.161	-0.120
Q.12.7	-0.426	-0.057	0.656	-0.443	0.288	0.116	-0.035	0.088	0.045	0.866	0.189	-0.127
Q.12.9	0.734	-0.043	-0.010	-0.161	0.180	-0.024	-0.093	-0.040	-0.071	0.733	-0.074	-0.010
Q.12.12	0.603	-0.015	0.135	-0.059	-0.023	-0.207	-0.136	0.187	-0.139	0.535	-0.278	0.091
Q.12.12.1	0.690	-0.005	0.299	-0.004	-0.166	-0.358	0.263	0.171	0.224	0.620	-0.245	0.076
Q.5.12.1*	0.217	-0.053	-0.015	-0.002	0.093	0.154	0.024	-0.045	0.083	-0.249	-0.028	0.039
Q.11.2a*	-0.066	-0.071	-0.049	-0.128	-0.063	0.165	0.082	-0.034	0.071	0.066	0.080	0.187
Q.11.2b*	-0.061	-0.063	0.003	-0.110	-0.080	0.120	0.043	-0.024	-0.001	-0.079	-0.108	-0.150
Q.11.10.1*	-0.022	0.050	-0.030	0.105	0.202	-0.048	-0.039	-0.145	-0.167	0.011	-0.068	0.042
Q.11.10.2*	-0.001	-0.055	0.045	-0.123	-0.190	0.072	0.095	0.090	0.202	0.011	-0.048	0.027
Q.11.11.1*	0.004	-0.141	-0.069	0.075	0.177	-0.023	-0.042	-0.080	-0.128	-0.026	-0.021	0.037
Q.11.11.2*	0.001	0.041	-0.096	0.070	0.202	-0.020	-0.050	-0.078	-0.077	-0.022	0.052	0.005
Q.12.6.1*	-0.192	0.046	0.080	0.055	0.153	-0.130	0.071	0.092	-0.007	-0.213	-0.025	-0.002
Q.12.12.3*	-0.087	-0.073	-0.171	0.126	0.029	-0.017	0.043	0.049	-0.113	0.129	-0.003	0.127
Q.12.19*	0.222	0.200	-0.026	-0.237	-0.086	-0.018	0.261	-0.088	0.149	-0.236	-0.107	-0.003
Q.12.38*	0.216	-0.040	0.108	0.063	-0.041	0.050	0.203	0.026	0.080	-0.192	0.069	-0.050
Q.12.39*	0.211	-0.074	0.002	-0.081	-0.155	0.100	0.195	-0.111	0.148	-0.269	-0.119	-0.008

*Supplementary variable

Source: Authors' calculations

Table A5

Object scores of each country by PC and supervision. Sorted list of countries in ascending order of object scores by PC. The object scores are the coordinates of each country in each PC.

Country	PC 1	Country	PC 2	Country	PC 3
Costa Rica	-0.565	Costa Rica	-3.589	Angola	0.155
Yemen	-0.500	China	-3.340	Argentina	0.305
Paraguay	-0.415	Yemen	-1.570	Armenia	0.126
Uruguay	-0.386	Lesotho	-1.042	Australia	0.172
Tajikistan	-0.336	Nepal	-0.938	Austria	0.346
Bhutan	-0.320	Myanmar	-0.844	Bahrain	0.205
Malta	-0.315	Cook Islands	-0.779	Bangladesh	0.334
Brazil	-0.308	Lebanon	-0.754	Belarus	0.172
Mauritius	-0.306	Jordan	-0.683	Belgium	0.175
Spain	-0.306	Paraguay	-0.645	Belize	0.227
Israel	-0.304	Swaziland	-0.563	WAEMU countries	0.223
Bosnia and Herzegovina	-0.304	Oman	-0.551	Bhutan	0.269
Cook Islands	-0.302	Korea	-0.499	Bosnia and Herzegovina	0.264
Venezuela	-0.300	El Salvador	-0.427	Botswana	0.063
Montenegro	-0.298	France	-0.336	Brazil	0.198
Philippines	-0.288	Kyrgyzstan	-0.320	Bulgaria	0.065
Russia	-0.287	Mauritius	-0.316	Burundi	0.258
Peru	-0.285	Namibia	-0.314	Canada	0.155
Isle of Man	-0.284	Zimbabwe	-0.311	Cayman Islands	0.119

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Table A5 (continued)

Country	PC 1	Country	PC 2	Country	PC 3
Romania	-0.280	Belize	-0.301	Chile	0.198
Madagascar	-0.279	Jersey	-0.295	China	0.666
Colombia	-0.277	Fiji	-0.287	Colombia	0.162
Portugal	-0.277	Australia	-0.282	Cook Islands	-0.864
Kosovo	-0.275	New Zealand	-0.282	Costa Rica	-10.046
Nicaragua	-0.272	Germany	-0.271	Croatia	0.285
Zimbabwe	-0.271	Brazil	-0.268	Cyprus	0.282
Slovenia	-0.269	Nigeria	-0.260	Denmark	0.184
Italy	-0.267	Malawi	-0.260	Dominican Republic	0.265
Serbia	-0.266	Vanuatu	-0.260	Ecuador	0.185
Australia	-0.264	Puerto Rico	-0.250	Egypt	0.249
Egypt	-0.264	Malta	-0.250	El Salvador	0.204
Kenya	-0.263	Tajikistan	-0.248	Estonia	0.254
Pakistan	-0.257	Moldova	-0.243	Ethiopia	0.200
Qatar	-0.254	Gibraltar	-0.241	Fiji	0.082
France	-0.251	Italy	-0.240	Finland	-0.767
Estonia	-0.246	Taiwan	-0.236	France	0.121
Jersey	-0.244	Sri Lanka	-0.225	Gambia	0.362
Taiwan	-0.240	Montenegro	-0.225	Germany	0.142
Lithuania	-0.240	Israel	-0.218	Ghana	0.222
Ecuador	-0.239	Hong Kong	-0.215	Gibraltar	0.133
Belize	-0.233	Macao	-0.212	Greece	0.019
Bulgaria	-0.228	Philippines	-0.211	Guatemala	-0.708
Kuwait	-0.227	Slovenia	-0.205	Guernsey	0.054
Suriname	-0.223	Estonia	-0.204	Guyana	0.254
Tunisia	-0.218	Luxembourg	-0.204	Honduras	0.204
Ghana	-0.217	Guernsey	-0.204	Hong Kong	0.179
Tanzania	-0.217	Peru	-0.203	Hungary	0.294
Sri Lanka	-0.216	Uruguay	-0.202	Iceland	0.278
Luxembourg	-0.216	Kenya	-0.202	India	0.062
Puerto Rico	-0.216	Madagascar	-0.201	Indonesia	0.230
Nigeria	-0.216	Romania	-0.199	Iraq	0.140
Croatia	-0.215	Kosovo	-0.198	Ireland	-1.968
Argentina	-0.212	Nicaragua	-0.192	Isle of Man	0.255
Burundi	-0.211	Venezuela	-0.192	Israel	0.092
Moldova	-0.207	Suriname	-0.187	Italy	0.202
Uganda	-0.206	Isle of Man	-0.181	Jamaica	-0.014
United Arab Emirates	-0.205	Egypt	-0.177	Jersey	0.132
WEMU countries	-0.201	Armenia	-0.170	Jordan	0.363
Macao	-0.190	Bhutan	-0.170	Kenya	0.189
Seychelles	-0.185	Bosnia and Herzegovina	-0.169	Korea	0.336
Malawi	-0.182	Kuwait	-0.159	Kosovo	0.186
Armenia	-0.182	Portugal	-0.157	Kuwait	0.244
Guyana	-0.181	South Africa	-0.143	Kyrgyzstan	0.100
Guernsey	-0.181	Spain	-0.136	Latvia	0.096
New Zealand	-0.179	Russia	-0.136	Lebanon	0.617
Maldives	-0.177	Bulgaria	-0.135	Lesotho	0.488
Bangladesh	-0.175	Greece	-0.127	Liechtenstein	-0.236
Belarus	-0.172	Qatar	-0.121	Lithuania	0.255
Austria	-0.171	Turkey	-0.117	Luxembourg	0.267
Kyrgyzstan	-0.171	Guyana	-0.116	Macao	0.097
Latvia	-0.169	Malaysia	-0.114	Madagascar	0.190
India	-0.168	Serbia	-0.113	Malawi	0.026
Switzerland	-0.164	Samoa	-0.109	Malaysia	0.082
Namibia	-0.164	Thailand	-0.108	Maldives	-0.117
Greece	-0.163	Canada	-0.107	Malta	0.143
Ethiopia	-0.161	Syrian Arab Republic	-0.107	Mauritius	0.232
Angola	-0.157	Pakistan	-0.103	Mexico	0.028
Chile	-0.155	Colombia	-0.101	Moldova	0.067
Vanuatu	-0.155	Latvia	-0.100	Montenegro	0.180
Trinidad and Tobago	-0.154	Belgium	-0.096	Morocco	-0.808
Syrian Arab Republic	-0.152	Tanzania	-0.095	Mozambique	0.096
Bahrain	-0.151	Uganda	-0.092	Myanmar	0.456
Malaysia	-0.146	Croatia	-0.079	Namibia	0.076
Iceland	-0.135	United Arab Emirates	-0.071	Nepal	0.556
Turkey	-0.132	Trinidad and Tobago	-0.059	Netherlands	0.311
Germany	-0.132	Ghana	-0.050	New Zealand	0.107
Indonesia	-0.131	Austria	-0.050	Nicaragua	0.183
Virgin Islands, British	-0.129	Angola	-0.046	Nigeria	0.117
Fiji	-0.128	Ethiopia	-0.032	Norway	-0.763

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Table A5 (continued)

Country	PC 1	Country	PC 2	Country	PC 3
South Africa	-0.126	Mozambique	-0.031	Oman	0.471
Belgium	-0.125	Chile	-0.031	Pakistan	0.220
Poland	-0.119	Seychelles	-0.026	Palestinian Territory	-0.786
Ukraine	-0.115	Bahrain	-0.026	Panama	0.206
Thailand	-0.104	WAEMU countries	-0.025	Paraguay	-0.919
Hong Kong	-0.098	Cayman Islands	-0.022	Peru	0.191
Honduras	-0.092	Poland	-0.020	Philippines	0.162
Hungary	-0.091	Iceland	-0.015	Poland	0.037
Iraq	-0.083	Bangladesh	-0.012	Portugal	0.217
Netherlands	-0.081	Burundi	-0.003	Puerto Rico	0.123
Gibraltar	-0.079	Switzerland	-0.002	Qatar	0.173
Swaziland	-0.074	Lithuania	0.001	Romania	0.254
Canada	-0.065	Denmark	0.010	Russia	0.089
Tonga	-0.063	Panama	0.012	Samoa	0.247
Dominican Republic	-0.061	Ecuador	0.023	Serbia	0.219
Samoa	-0.048	Sierra Leone	0.031	Seychelles	0.196
Sierra Leone	-0.046	Honduras	0.045	Sierra Leone	0.336
El Salvador	-0.045	Virgin Islands, British	0.046	Slovakia	-0.300
Gambia	-0.042	Tonga	0.048	Slovenia	0.201
Mozambique	-0.013	Indonesia	0.049	South Africa	0.022
Liechtenstein	-0.009	Botswana	0.053	Spain	0.217
Jamaica	-0.002	Gambia	0.057	Sri Lanka	0.191
United States	-0.001	Argentina	0.066	Suriname	0.260
Panama	0.003	Iraq	0.082	Swaziland	-1.068
Botswana	0.016	United States	0.085	Switzerland	0.190
Denmark	0.017	Netherlands	0.094	Syrian Arab Republic	0.225
Cyprus	0.018	Ukraine	0.095	Taiwan	0.177
Cayman Islands	0.043	Hungary	0.098	Tajikistan	0.210
Slovakia	0.061	Cyprus	0.122	Tanzania	0.228
Mexico	0.096	Dominican Republic	0.130	Thailand	0.292
Finland	0.122	Belarus	0.132	Tonga	0.256
Guatemala	0.252	India	0.237	Trinidad and Tobago	0.283
Jordan	0.287	Tunisia	0.258	Tunisia	0.045
Nepal	0.317	Maldives	0.700	Turkey	0.205
Palestinian Territory	0.331	Jamaica	0.717	Uganda	0.250
Morocco	0.370	Mexico	0.797	Ukraine	0.308
Oman	0.503	Slovakia	0.976	United Arab Emirates	0.319
Lebanon	0.525	Liechtenstein	1.134	United Kingdom	-2.610
Korea	0.641	Norway	2.212	United States	0.243
Ireland	0.953	Finland	2.715	Uruguay	0.241
Myanmar	1.092	Palestinian Territory	2.746	Vanuatu	0.273
Lesotho	1.236	Guatemala	2.759	Venezuela	0.249
Norway	1.495	Morocco	3.013	Virgin Islands, British	0.309
United Kingdom	3.563	Ireland	4.748	Yemen	-3.123
China	10.415	United Kingdom	5.964	Zimbabwe	0.248

Source: Authors' calculations

Appendix B

Let P be the number of principal components (called “dimensions” in the CATPCA output) extracted. For the vector model, an $N \times P$ matrix X includes the coordinates of the N countries in the P -dimensional Euclidean space. In contrast, an $M_v \times P$ matrix A gives the coordinates for the endpoints of the M_v variables’ vectors in the same space P . a_m denotes the vector that gives the coordinates representing the m th variable, and G_m is the indicator matrix that classifies each country in one and only one category. Furthermore, let the optimal category qualifications be included in the C_m -vector y_m , where C_m represents the number of categories of the m th variable. The loss function to be minimized for the vector model is then given as follows:

$$L_V(Y_v; A; X) = M_v^{-1} \sum_{m \in K_v} \|G_m Y_m a'_m - X\|^2 \tag{1}$$

where y_v is a vector with length $\sum_{m \in K_v} C_m$ comprising the quantifications for the M_v RS variables. K_v is the index set containing the indices of the variables included in the vector model. In (1), the projection of the object points of the matrix X against the vector a_m represents (approximately) the optimally quantified variable $q_m = G_m y_m$ in the representation space P . Following Meulman et al. (2004), X is approximated by the inner product $G_m y_m a'_m$ (the coordinates of the m th variable on the straight line through the origin in the P space).

For the centroid model, the objective function is represented in (2), where a $C_m \times P$ matrix Y_m includes the categories coordinates in the P -dimensional space:

$$L_B(Y_B; X) = M_B^{-1} \sum_{m \in K_B} \|G_m Y_m - X\|^2 \quad (2)$$

where Y_B comprises the quantities for the M_B variables, and K_B is the index set of the variables in the centroid model. This objective function implies that an object point in X must coincide with its associated category point in one of the Y_m rows to obtain the perfect fit; see Meulman et al. (2004) for details.

The joint objective function for CATPCA is a linear combination of both (1) and (2), as follows:

$$L(Y; A; X) = (M_V + M_B)^{-1} [M_V L_V(Y_V; A; X) + M_B L_B(Y_B; X)] \quad (3)$$

where part one is minimized for the m variables represented as a vector, and part two is minimized for the representation of the categorical variables. Hence, the optimal \hat{X} is given by Eq. (4), which allows object scores to be orthonormalized as $\hat{X}'\hat{X} = NI$ (uncorrelated).

$$\hat{X} = M^{-1} \left[\sum_{m \in K_V} G_m Y_m + \sum_{m \in K_B} G_m Y_m \right] \quad (4)$$

Appendix C. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.ribaf.2023.102059](https://doi.org/10.1016/j.ribaf.2023.102059).

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