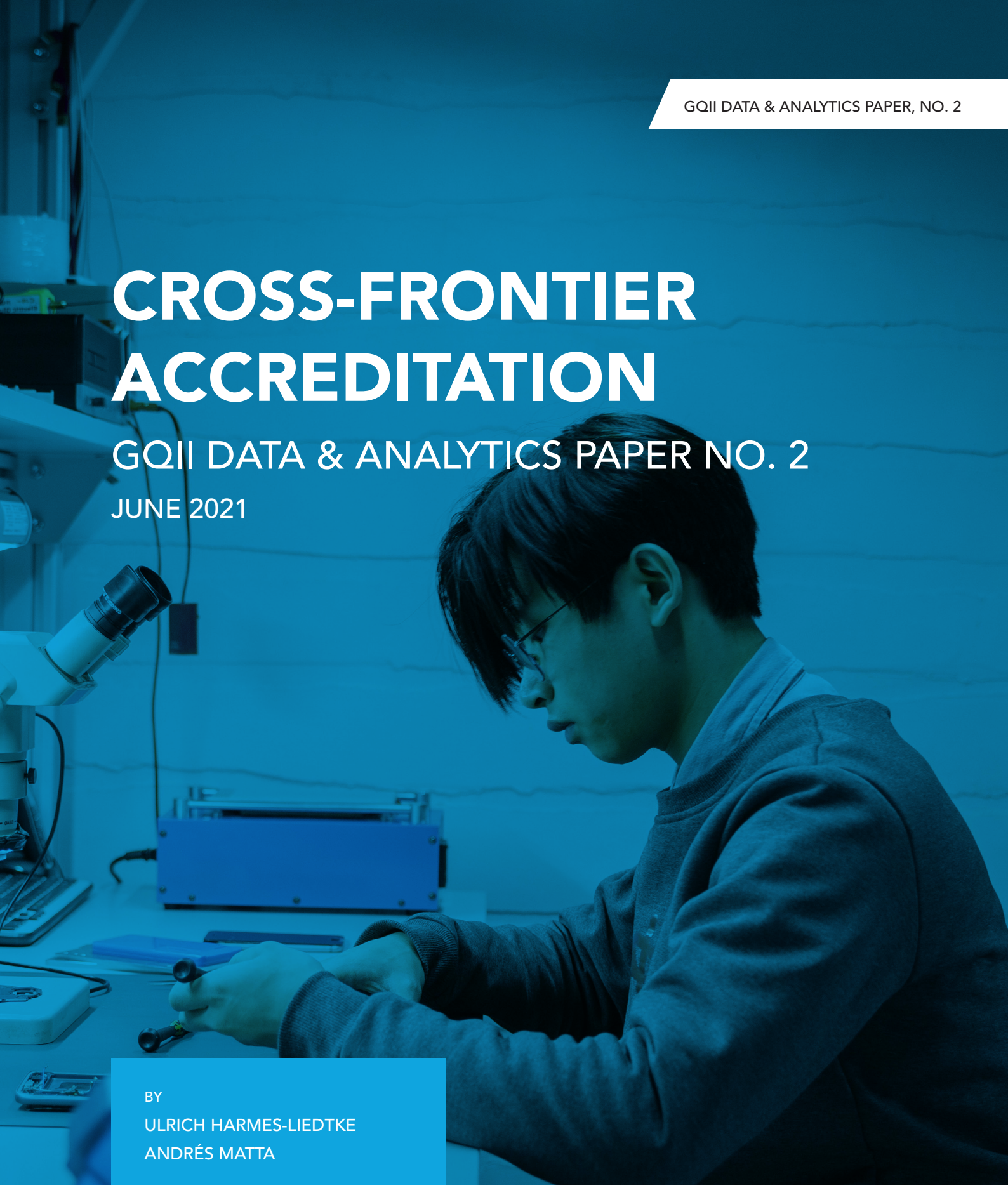

CROSS-FRONTIER ACCREDITATION

GQII DATA & ANALYTICS PAPER NO. 2

JUNE 2021

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GQII
GLOBAL QUALITY INFRASTRUCTURE INDEX

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LIST OF ACRONYMS

AB	Accreditation Body
AFRAC	African Accreditation Cooperation
ANOVA	Analysis of variance
APAC	Asia-Pacific Accreditation Cooperation Incorporated
APLAC	Asia-Pacific Laboratory Accreditation Cooperation
ARAC	Arab Accreditation Cooperation
CAB	Conformity Assessment Body
CB	Certification Body
CFA	Cross-Frontier Accreditation
CL	Calibration Laboratory
EA	European Co-operation for Accreditation
IAAC	Inter-American Accreditation Cooperation
IAF	International Accreditation Forum
IEC	International Electrotechnical Commission
ILAC	International Laboratory Accreditation Cooperation
ISO	International Organization for Standardisation
ML	Medical Laboratory
MLA	Multi-Lateral Recognition Arrangement (the term used by the IAF)
MRA	Mutual Recognition Arrangement (the term used by ILAC)
NAFP	National Accreditation Focal Points
NAB	National Accreditation Body
PAC	Pacific Accreditation Cooperation
RAC	Regional Accreditation Cooperation
s/a	Economies not associated with any RAC
SADCA	Southern African Development Cooperation in Accreditation
SADCAS	Southern African Development Community Accreditation Services
SNA	Social Network Analysis
WTO	World Trade Organisation

1

INTRODUCTION

DEFINITION AND AREAS OF APPLICATION

In the context of international trade, accreditation is the formal attestation or statement by an independent third party (the accreditation body, AB) that a conformity assessment body (CAB) or calibration laboratory (CL) is competent to carry out a specific conformity assessment or calibration services[1]. The statement is based on the positive outcome of a review determining whether the CAB or CL fulfils the relevant criteria for its accreditation. Formally, accreditation is based on international standards of the International Standards Organization and International Electrotechnical Commission (ISO/IEC17000:2020 series conformity assessment).[2]

Accreditation originated after World War II in laboratory services, coordinated through the International Laboratory Accreditation Cooperation (ILAC). The accreditation of certification bodies (CB) came much later and is organised within the International Accreditation Forum (IAF). ILAC and IAF are currently in the process of merging, and regional accreditation cooperations (RACs) APLAC, ARAC, AFRAC, IAAC, EA, PAC and SADCA are assigned to them. Essential for the spread of accreditation are the World Trade Organization's (WTO) related regulations in the Agreement on Technical Barriers to Trade (TBT) and the Agreement on Sanitary and Phytosanitary Measures (SPS). Besides, private certification systems such as GLOBAL G.A.P., FAMI-QS and the Food Safety System Certification (FSSC) or the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) also use the accreditation systems of ILAC and IAF to recognise certification bodies (see Table 1).

INTERNATIONAL AND REGIONAL RECOGNITION

Accreditation is the central mechanism of cross-frontier recognition of conformity assessment services. The slogan is "accredited once, accepted everywhere".[3]

The recognition of technical competence and impartiality of NABs is regulated within the international and regional accreditation cooperations. For this purpose, the NABs sign the Mutual Recognition Arrangement (MRA) of ILAC and the Multilateral Recognition Agreement (MLA) of IAF. In this way, the signatories undertake to recognise the accreditations of CABs and their conformity assessment results across frontiers.

Multilateral arrangements strengthen the confidence of companies, regulatory authorities and stakeholders in test and inspection reports, certificates of CABs and calibrations laboratories. In consequence, MRAs and MLAs promote the global movement of goods and services.

The list of signatories to the ILAC MRA can be found on the ILAC website.[4] It is important to note that the technical competence of an AB is only recognised for specific accreditation scopes. Therefore it is important to check with an AB which international recognition scopes are covered by the MLA or MRA.

For accreditation bodies which do not fulfil the requirements of IAF or ILAC, there is often the possibility of an MLA within an RAC or a bilateral agreement. If an AB signs a mutual recognition agreement at the RAC level, these accreditation services are recognised across the specific world region, but without automatically being accepted by all ILAC/IAF MRA members.

[1] The authors would like to thank Manfred Kindler for his comments on an earlier version of this paper.

[2] https://www.iso.org/obp/ui/#iso:std:iso-iec:17000:ed-2:v2:en

[3] See e.g. https://ilac.org/ilac-mra-and-signatories/benefits/ and https://european-accreditation.org/mutual-recognition/iaf-ilac-recognition/

[4] https://ilac.org/ilac-mra-and-signatories/ (Retrieved 04/04/21).

NATIONAL ACCREDITATION BODIES AND CROSS-FRONTIER ACCREDITATION

One economy, one accreditation body

The accreditation of CABs is mainly organised nationally. The principle of "one economy, one accreditation body" applies generally, but there are exceptions:

1. Economies with more than one accreditation body
Some economies, e.g. the United States, India, Japan and South Korea, have several accreditation bodies in the country. In the United States, several ABs are competing in different accreditation areas. Meanwhile, in other economies there is a division of labour, with some ABs specialising in laboratory accreditation and others in accreditation of CBs. In the European Union, the principle of one AB by country now applies to all member states.

2. Binational and regional accreditation bodies
Other exceptions are binational and regional ABs. The Joint Accreditation System for Australia and New Zealand (JAS-ANZ) is responsible for the Accreditation of CBs in both countries.

Another example is the Southern African Development Community Accreditation Services (SADCAS), a multi-economy accreditation body. SADCAS services the accreditation needs of fourteen (14) Southern African Development Community (SADC) member states, namely Angola, Botswana, Comoros, Democratic Republic of Congo (DRC), Eswatini, Lesotho, Madagascar, Malawi, Mozambique, Namibia, Seychelles, Tanzania, Zambia and Zimbabwe. The headquarters of SADCAS are in Gaborone in Botswana.

3. Economies without their own accreditation body
Not all countries or economies have an accreditation body. In smaller and less developed countries, the critical demand necessary for the establishment of an NAB is often lacking. Some of these economies have established National Accreditation Focal Points (NAFPs). NAFPs are competent bodies in countries without their own accreditation bodies, which act as information intermediaries between the local users and suppliers of conformity assessment and the ABs abroad. NAFPs have become a widespread tool in regional cooperation communities to establish national accreditation systems or to coordinate accreditation activities with internationally recognised accreditation bodies in a structured manner.[5] However, an NAFP is not a formal part of international accreditation cooperation.

Cross-frontier accreditation

The rule is that accreditation services are provided in the same country or economies. However, there are several exceptions that require an AB to provide its services abroad. This is called cross-frontier accreditation. Economically speaking, this is a case of trade (export or import depending on the perspective) in services.

The international accreditation community is concerned with preventing competition between national accreditation bodies or limiting it to well-defined facts.[6] There are legitimate reasons for cross-frontier accreditation:

- if an economy does not have its own accreditation body
- if the domestic accreditation body does not offer accreditation for the required scope
- if the economy's accreditation body has not received a positive result in a peer evaluation[7]
- if the CAB clients require accreditation by a specific accreditation body and will not be persuaded to accept the domestic equivalent
- by request of CAB headquarters
- if certification bodies are internationally organised, e.g. SGS, TÜV and other global players, recognition can be transferred to other countries.

Especially for developing countries that do not (yet) have their own NAB, cross-frontier accreditation offers the possibility to develop the technical competence and independence of local CABs (especially testing and calibration laboratories, and certification and inspection bodies) recognised internationally. Importing these services makes it easier for these countries to participate in global trade.

Additionally, cross-frontier accreditation (CFA) is an excellent training module for the development of further accreditation services (Joint Assessments and Joint Accreditations).

Countries with their own NAB can also benefit from cross-frontier accreditation (CFA). This applies if the NAB only has international recognition of limited scopes. In the remaining areas, the services that are absent can be offered to the local users and providers of conformity assessment. This is a challenge, however, when the NAB expands its competences. In this case, the coordination of all stakeholders is needed to support the transfer of accreditation services to the NAB.

METHODOLOGY

In this study, the authors deal with the empirical significance of cross-frontier accreditation. For this purpose, the authors collected data on accreditation from the websites of 201 accreditation bodies in 184 economies.[8] In doing so, the authors distinguished between the types of accreditation on level 5 (see Table 1) to determine whether the services were provided for a conformity assessment body at home or abroad.

[5] https://www.ptb.de/cms/fileadmin/internet/fachabteilungen/abteilung_9/9.3_internationale_zusammenarbeit/publikationen/PTB_Info_NAFP_EN_02.pdf (Retrieved 22/03/2021).

[6] See also the explanations in Chapter 2.

[7] Accreditation bodies are admitted to the IAF MLA and the ILAC MRA only after a most stringent evaluation of their operations by a peer evaluation team which is charged to ensure that the applicant member complies fully with both the international standards and IAF or ILAC requirements.

[8] Like IAF and ILAC, we use the term economy instead of country, which thereby establishes the fact that the sample comprises different territorial units which are not independent countries. These include Hong Kong, Macao and Taiwan, which are counted in with the People's Republic of China, and also Palestine and Kosovo.

	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
IAF MLA	Product Certification	ISO/IEC 17065:2012	GLOBALG.A.P IFA General Regulations V4	GLOBALG.A.P IFA Control Points and Compliance Criteria V4
	Management System Certification	ISO/IEC 17021-1:2015	ISO/TS 22003:2013	ISO 22000:2018, 2005 (FSMS)
			ISO/TS 22003:2013 FAMI-QS Rules for Certification Bodies Version 8	FAMI-QS Certification Scheme Code Version 6
			ISO/IEC 17021-3:2017	ISO 9001:2015 (QMS)
			ISO/IEC 17021-2:2016	ISO 14001:2015 (EMS)
			ISO/IEC 27006:2015	ISO/IEC 27001:2013 (ISMS)
			ISO 5003:2014	ISO 50001:2018, 2011 (EnMS)
				ISO 13485:2016 (MDMS)
			ISO/IEC TS 17021-10:2018	ISO 45001:2018 (previous OHSAS 18001)
			ISO/TS 2003:2013 FSSC Scheme Part 3 – Requirements for the Certification Process FSSC Scheme Part 4 – Requirements for Certification Bodies	FSSC Scheme Part 2 – Requirements for organizations to be audited
	Person Certification	ISO/IEC 17024:2012		IPC PL-11-006
	Validation and Verification	ISO 14065:2013	ICAO CORSIA ETM – Volume IV V1, ISP 14064-3:2006; ISO 14066:2011	ICAO CORSIA SARPs – Annex 16 Volume IV VI
		ISO/IEC 17029:2019		
ILAC MRA	Testing	ISO/IEC 17025		Scope of accreditation
			WADA ISL	
		ISO 15189		
			ISO 22870	
	Calibration	ISO/IEC 17025		
			ISO 15195	
	Inspection	ISO/IEC 17020		
	Proficiency Testing	ISO/IEC 17043		
	Reference Material Production	ISO 17034		

Reference: Authors' elaboration based on IAF MLA status 23/02/2011 and ILAC-R6:05/2019

The authors evaluated and systematised the international trade relations of accreditation services between the economies using the Social Network Analysis (SNA).

SNA is a field of data analytics that uses networks and graph theory to understand social structures. It helps to understand growing interdependencies of social relations on a theoretically and methodologically sound foundation (Prell, 2012). The authors expect valuable insights from the application of network analysis, especially for accreditation and quality infrastructure, where the systematic use of statistical data to observe the development of the system itself is only in its infancy.

This study shows for the first time the patterns of cross-frontier accreditation. The authors hope that these findings will provide the international accreditation community with new information to guide the collaboration in accreditation across borders.

2

GUIDELINES

INTERNATIONAL POLICIES AND GUIDELINES

Overview

The standards of the ISO/IEC 17000 series provide regulations concerning the assessment of CABs by an AB, which carry out certifications and tests or inspection reports in countries outside the country where their head office is located. These regulations are specified in the multilateral agreements and guidelines of IAF and ILAC. While not banning ABs from offering accreditation to CABs from outside its borders, the accreditation body is fully expected to promote the multilateral agreements of both ILAC and IAF, and to inform interested parties that accreditation should be sought from the local accreditation body, subject to their being signatories to the appropriate ILAC or IAF multilateral agreements. Regional accreditation cooperations (AFRAC, APAC, EA and IAAC) as well as national accreditation bodies take over these agreements and define them according to their own rules.

ILAC coordination principles of cross-frontier accreditation

In 2001 the ILAC Arrangement Committee prepared the first document on cooperation principles for cross-frontier accreditation. The current version of the document, G21:09 drawn up in 2012, is under revision.[9] The document serves to strengthen the international network of accreditation bodies through the ILAC arrangement, and mentions the following purposes:

(1) The ILAC Mutual Recognition Arrangement (the Arrangement) is designed to ensure that endorsed test reports and calibration certificates issued by laboratories and endorsed inspection reports issued by inspection bodies accredited by ILAC Full Members (i.e. signatories to the ILAC Arrangement) under their defined scopes of accreditation can be accepted worldwide.

(2) ILAC's objective is to offer the benefits of the Arrangement to the market so that duplicate accreditation will not be necessary.

(3) For this to be achieved, each accreditation body signatory to the Arrangement must provide an equivalent accreditation service. This equivalence is ensured by a peer evaluation process managed under the Arrangement.

(4) The principles set out in this document serve to strengthen the international network of accreditation bodies through the Arrangement. These accreditation bodies accredit laboratories and inspection bodies, which carry out conformity assessment activities in different economies. The principles seek to assist the objective of facilitating international trade by removing technical barriers to trade.

The document gives examples of when a laboratory or inspection body might apply for accreditation from a body outside its own country (economy):

a) There is no domestic accreditation body.

b) The domestic accreditation body does not offer accreditation for the required scope.

c) The domestic accreditation body is not a signatory to the ILAC Arrangement.

d) The laboratory's or inspection body's clients require accreditation by a specific accreditation body and will not be persuaded to accept the domestic equivalent.

e) The laboratories or inspection bodies are part of a group that wants all their laboratories or inspection bodies to be accredited by the same accreditation body.

Where one or more domestic accreditation bodies that are ILAC MRA signatories for the requested scope of accreditation are present in the country (economy) of the applicant, and the applicant still elects to apply for accreditation from the foreign accreditation body, the foreign accreditation body should, in accordance with the requirement of having a program to promote the ILAC Arrangement with major stakeholders, take the following steps

[9] https://ilac.org/publications-and-resources/ilac-guidance-series/

before accepting the application:

(1) Enquire whether the applicant is aware of the domestic accreditation body.
(2) Suggest that accreditation provided by a domestic accreditation body would better take account of local factors and conditions, where relevant.
(3) Point out the equivalence of the domestic accreditation body's accreditations as demonstrated through the ILAC Arrangement.
(4) Point out that, according to the cross-frontier accreditation principles of ILAC, even if the application is accepted the local accreditation body may be involved in the accreditation process.

The foreign accreditation body should proceed with the application only if the applicant persists in requiring accreditation by the foreign accreditation body; and it shall seek acceptance from the applicant before consulting with the domestic accreditation body.

When an accreditation body that is a signatory to the ILAC Arrangement decides to provide accreditation services outside its own country (economy), it should ensure that appropriate assessors are used, considering factors such as language, local laws and regulations, culture, etc., as well as technical competence requirements. It is recommended that key representatives of the local government (ministries or authorities) be involved to ensure national recognition and licensing later on. The foreign accreditation body should consult the domestic accreditation body and take into consideration any relevant accreditation requirements that the domestic accreditation body has set to suit local conditions.

The preferred ILAC approach to ensure access to relevant competence is to cooperate to the greatest practical extent with the domestic accreditation body by using its personnel, as appropriate, on the assessment team. If it is not possible to include personnel from the domestic accreditation body on the assessment team, cooperation with the domestic accreditation body should be extended by inviting the domestic accreditation body to observe the assessment, subject to acceptance by the applicant.

Where the domestic accreditation body is not a signatory to the ILAC Arrangement, or where the scope of the domestic accreditation body does not cover the requested activity, the foreign accreditation body should try to cooperate with the domestic accreditation body according to these principles to provide the domestic accreditation body with the opportunity to gain experience to apply for the ILAC Arrangement. The principles for cooperation among ILAC member bodies also apply to reassessment and surveillance activities performed by an accreditation body outside its own country (economy).[10]

In all cases, the objective of an eventual change, with the accreditation moving to the relevant domestic accreditation body, should be borne in mind when the domestic accreditation body becomes a signatory to the ILAC Arrangement for the relevant scope, or when the applicant laboratory or inspection body so chooses.

IAF assessment for cross-frontier accreditation activities

The IAF Document for Assessment of Certification Activities for Cross-Frontier Accreditation is mandatory for IAF MLA signatories.[11] The AB shall have an assessment program covering the current accreditation period that enables it to confirm the CAB's conformity with the requirements of the relevant conformity assessment standard(s) within the CAB's scope of accreditation, irrespective of where certification activities are performed. The AB's assessment program shall be developed to identify key activities to be assessed and the countries where these are performed or managed and shall be reviewed annually.

[10] This tool is also known as Joint Assessment and Joint Accreditation and was already introduced in the 1990s by Manfred Kindler as part of his 30 Milestones programme in an EU project in Eastern Europe.
[11] AF 2013, MD 12, https://www.iaf.nu/upFiles/IAF_MD_12_Assessment_of_Certification_Activities_for_Cross_Frontier_Accreditation__Final.pdf

CROSS-FRONTIER ACCREDITATION WITHIN EUROPE

Within the European Cooperation for Accreditation (EA), the rules on cross-frontier accreditation are tightly governed by the European Accreditation Regulation: Reg (EC) No. 765/2008. This concept is an excellent demonstration of the combination of mandatory and voluntary accreditation schemes.

The European regulation provides for a comprehensive horizontal legal framework for the operation and organisation of accreditation in the European Economic Area (EEA) 6 applicable as from 1 January 2010. The regulation formalises a set of requirements for accreditation bodies in line with the relevant ISO/IEC international standards. Some of the EC regulations go beyond the requirements set out in the ISO/IEC standards, namely:

- Accreditation is carried out by one single national accreditation body appointed by its Member State (Article 4.1)
- Accreditation is performed as a public authority activity (Article 4.5)
- National accreditation bodies operate free from commercial motivations (Article 8.1) and on a not-for-profit basis (Article 4.7)
- National accreditation bodies do not compete with conformity assessment bodies and among each other (Articles 6.1 anD 6.2)

Cross-frontier accreditation is carried out only under certain limited circumstances (Article 7): European conformity assessment bodies are required to request the accreditation by the national accreditation body of the member state in which they are established.
This general rule allows limited exceptions when a CAB requests accreditation with a NAB in another member state where:

- there is no NAB in its member state (Article 7.1(a))
- the NAB does not offer the requested accreditation service (Article 7.1(b))
- the NAB has not received a positive outcome in the peer evaluation concerning the conformity assessment activity for which accreditation is requested (Article 7.1(c)).

Article 7.1 of the Regulation is closely linked to, and is a logical consequence of, the non-competition principle embodied in Article 6 of the same Regulation. It is crucial to prevent conformity assessment bodies from shopping around for accreditation certificates, thus creating a "market for accreditation", leading to the commercialisation of accreditation, which jeopardises the added value of accreditation and its role as a public authority activity and last level of control of the conformity assessment chain.

Although Reg (EC) No. 765/2008 is very stringent about restricting cross-frontier accreditation within Europe, it does allow exceptions:
(1) Where the member state does not have its own accreditation body. The accreditation body is not a signatory to the relevant EA Multilateral Agreement (MLA), or where the regional accreditation body cannot provide the CAB with the accreditation service that it is seeking.
(2) Where an overseas CAB is part of a corporate group whose head office is situated in a different member state. In this instance the local accreditation body of the head office can provide a single accreditation to cover all sites if they meet the well-defined requirements.[12]

[12] EA Publication EA-2/13 https://european-accreditation.org/publication/ea-2-13-m-rev01-october-2012 (Retrieved 04/04/2021).

3

NETWORK ANALYSIS OF CROSS-FRONTIER ACCREDITATION

DATA BASE AND COLLECTION

To better understand the practice of cross-frontier accreditation, the authors collected and analysed data from 201 freely accessible AB websites worldwide.[13] These are signatories of mutual arrangements of IAF, ILAC and RAC as well as ABs that do not (yet) have an internationally recognised AB. The counting is of certificates (not sites) for the accreditation scopes at level 5 (see Table 1).

For this study, the authors used the Alpha-3 codes as described in the ISO 3166 international standard to designate the countries/economies.[14] In countries with more than one AB, they aggregated the data at the country or economy level.

To analyse the data of the cross-frontier accreditation, the authors chose social network analysis (SNA). This is a method of empirical social research for recording and analysing social relationships and social networks. SNA propagates a particular view of social phenomena that emphasises their relational character. Connections and interdependencies between entities (in our case accreditation bodies and conformity assessment bodies or economies) are the unit of analysis (Prell, 2012). For the computations and visualisation of the networks, the authors used the UCINET program (Borgatti, 2002).

ANALYSIS OF THE GLOBAL STRUCTURE: CENTRALITY

The cross-frontier accreditation network analysis at the global level recorded the accreditation service data from May to September 2020, which included 146 economies with 2,878 accreditation services provided between them.[15] All these accreditations generated 339 international links, representing a density of 1.6% of all possible relationships.[16]

Figure 1 shows how these links are structured, making it possible to identify this as a strongly centralised network in terms of service provision, although with a diversified scope. Using Freeman's measure of centrality (Freeman, 1978),[17] the analysis indicates that the export network is 67% centralised globally while at the import level, this value is 6.73%.

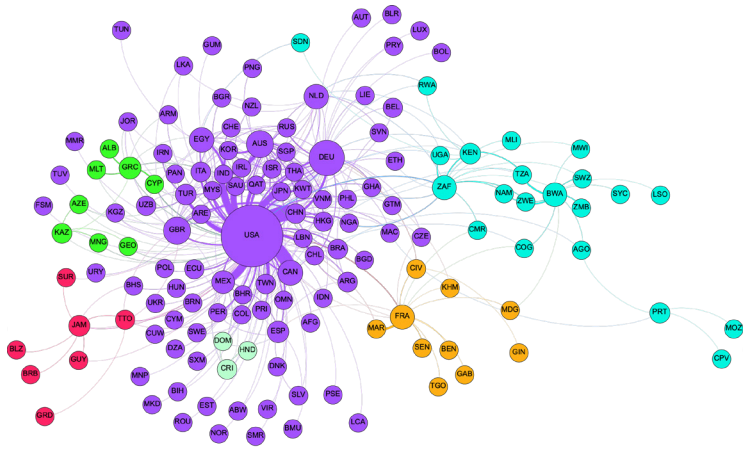


Figure 1: Links of cross-frontier accreditation

Reference: Author's elaboration. The results of the execution of the "modularity" algorithm (Blondel, Guillaume, Lambiotte and Lefebvre, 2008) are represented by different colours.

[13] For more information on the data base, see https://gqii.org.

[14] https://www.iso.org/iso-3166-country-codes.html and https://en.wikipedia.org/wiki/ISO_3166-1_alpha-3.

[15] According to GQII data, the AB had attested 108,208 accreditations worldwide (Harmes-Liedtke & Oteiza, 2021). This means that cross-frontier accreditations account for 2.7% of the total number of accreditations.

[16] The density of a network is calculated as the sum of tie values divided by the number of possible ties. In our case, the calculation is 336 links/ ((146 countries)2 - 146 countries) = 1,6%.

[17] This measure expresses the degree of inequality or variance of the network in relation to a fully centralised theoretical network (in the shape of a star). Measures of degree cannot be directly compared when networks differ in size. Realising this, Freeman (1979) developed a normalised centrality measure, which converts the degree, in-degree and out-degree centrality scores into proportions. Through this technique Freeman enabled analysts to compare the centrality of actors from one network to the next (Prell, 2012:100).

The high centralisation of exports of accreditation services can be analysed from Table 2, which shows the links of the top ten (10) exporting economies.[18]

The top ten accreditation service exporters accumulate 91% of the cross-frontier accreditations, being simultaneously the most connected as they concentrate 77% of the links between economies. Within this select group of economies, there are also notable asymmetries, since the USA represents 64% of the accreditations and 29% of the links. This is followed by a group of economies including Australia (AUS), Germany (DEU) and the United Kingdom of Great Britain and Northern Ireland (GBR) and, to a lesser extent, Canada (CAN), Egypt (EGY), the Netherlands (NLD), South Africa (ZAF), France (FRA) and Botswana (BWA).

ECONOMY	NUMBER OF RELATIONS (EXPORT)	% INTERNATIONAL RELATIONS (EXPORT)	NUMBER OF ACCREDITATIONS (EXPORT)	% CROSS-FRONTIER ACCREDITATIONS (EXPORT)
USA	99	29%	1848	64%
DEU	39	12%	143	5%
AUS	20	6%	207	7%
GBR	20	6%	73	3%
CAN	15	5%	36	1%
EGY	14	4%	57	2%
NLD	14	4%	27	1%
ZAF	13	4%	65	3%
FRA	13	4%	59	2%
BWA	11	3%	82	3%
Total	258	77%	2597	91%

Table 2: Accreditation export by country
Reference: Author's elaboration

In the case of economies that import these services, the authors selected in Table 3 the top 16 economies in which import accreditations also show some degree of centrality, although less than the previous Table 2. These economies account for 46% of imported accreditations and 25% of links between economies. China (CHN) stands out in this group, representing 13% of imported benefits and 4% of links. It is followed by a group of economies, among which are India (IND), Japan (JPN), Peru (PER), Republic of Korea (KOR) and the United Arab Emirates (ARE). In this case, there are fewer asymmetries and a lower correlation between the number of imported services and the size of the international network generated for this purpose.

[18] Note that only 32 economies have exported during the period under review.

ECONOMY	NUMBER OF RELATIONS (IMPORT)	% INTERNATIONAL RELATIONS (IMPORT)	NUMBER OF ACCREDITATIONS (IMPORT)	% CROSS-FRONTIER ACCREDITATIONS (IMPORT)
CHN	12	4%	379	13%
IND	8	2%	207	7%
USA	7	2%	61	2%
JPN	7	2%	145	5%
PER	7	2%	27	1%
HKG	6	2%	47	2%
RUS	6	2%	33	1%
EGY	5	1%	21	1%
CHL	5	1%	61	2%
ARE	5	1%	72	3%
KOR	5	1%	76	3%
MYS	5	1%	40	1%
QAT	5	1%	62	2%
CAN	2	1%	235	1%
MEX	3	1%	142	1%
UAA	4	1%	118	1%
Total	92	25%	1726	46%

Table 3: Accreditation import by country
Reference: Author's elaboration

ANALYSIS OF THE GLOBAL STRUCTURE: BLOCS AND GROUPINGS

Figure 2 reflects the positions of the economies on the world map. It also represents the results of the execution of the "modularity" algorithm different colours (Blondel, Guillaume, Lambiotte and Lefebvre, 2008), which allows relationship patterns to be observed that explain the way in which transnational accreditation links occur.[19] In this first exploration, the reader can observe a large bloc of 93 economies (64% of the total) which is clearly influenced by the strong presence of the USA (with exports to 99 economies) and therefore crosses all continents.

There are other blocs with more dense relations: the economies of southern Africa (led by South Africa (RSA) and Botswana (BWA) as the host country of SADCAS), a group of fundamentally African economies linked particularly to France (FRA); another bloc forming an axis that runs from the eastern Mediterranean to Mongolia (MNG), led by Greece (GRC) and Kazakhstan (KAZ); and two small groups located in Central America and the Caribbean led by Jamaica (JAM) and Costa Rica (CRI).

[19] This heuristic method is based on an algorithm that finds partitions in the networks, based on an iterative process that is repeated until an optimal result is achieved. This consists of the situation in which the relationships within the block are maximised and the relationships between partitions are minimised.

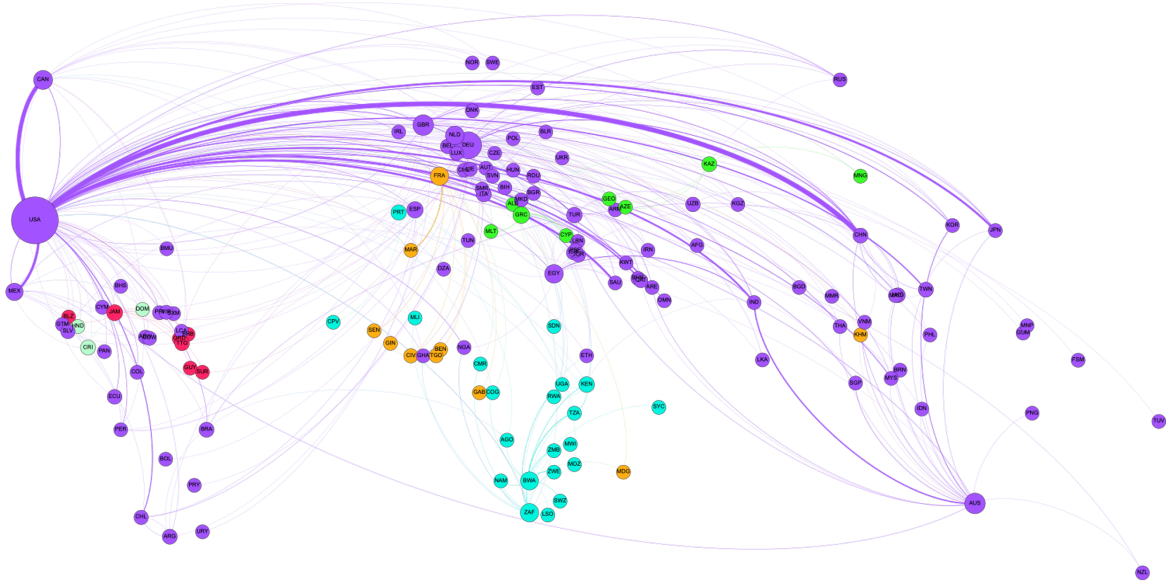


Figure 2: Grouping of economies by executing the "modularity" algorithm

Although this first analysis is purely inductive, it indicates a relevant territorial dimension in the establishment of relationships. This analysis already alludes to sub-regional cooperation contexts.

In order to analyse the influence of membership of the different Regional Accreditation Cooperations (RACs)[20] and geographical proximity on the existence of transnational relationships, the authors have a carried out a set of specific tests.

A first analysis from the Relational Contingency Table studies the way density differs within and between groups compared to an expected random distribution[21] shows the results of this analysis. Clearly recognisable are distinct cooperation relationships in different regions of the world (the Americas (orange), Europe (light green), Arab countries (red), Southern Africa (dark green) and Asia-Pacific (light blue)). The remaining group of non-signatory economies is scattered around the globe in an east-west direction. This distribution is similar to the territorial boundaries of the RACs.

[26] BIPM, The first 17, Sèvres/ France, https://www.bipm.org/en/about-us/member-states/original_seventeen.html. (Retrieved 13/03/2021)

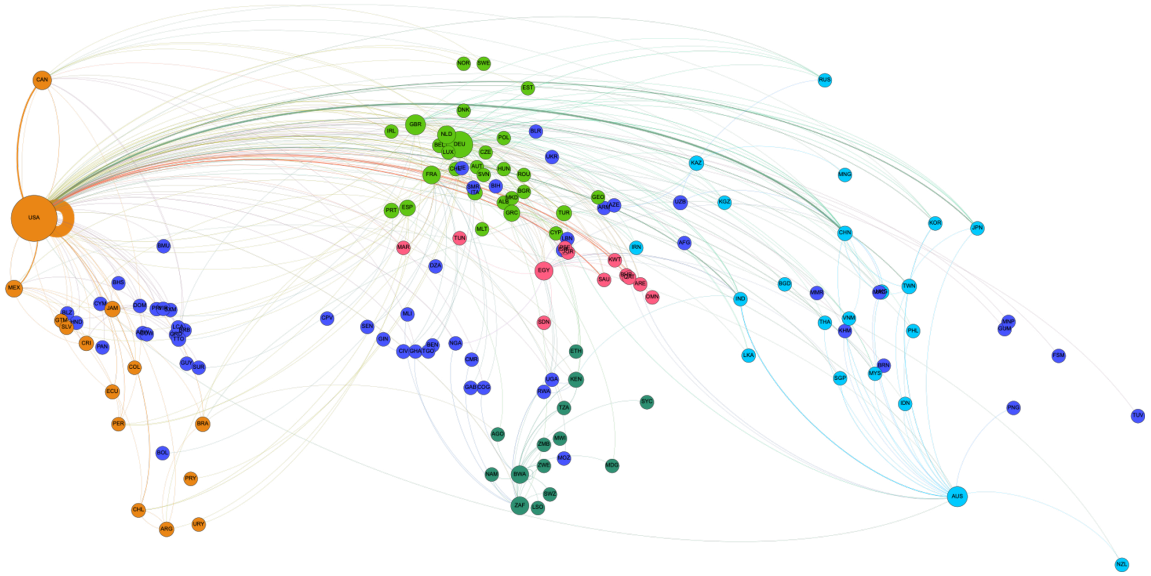
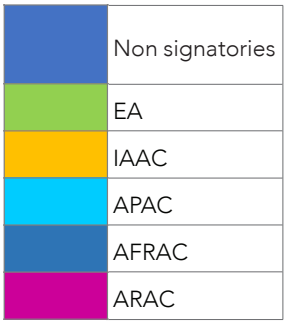


Figure 2: Grouping of economies by executing the "modularity" algorithm

Table 4 shows the observed accreditation trade densities between the RACs. The rows refer to the density of exports, whereas the columns refer to the density of imports. The highlighted diagonal values show the accreditation activity between accreditation points from one and the same region. In almost all RACs (IAAC, APAC, AFRAC, ARAC), the export ratios within the group are higher than those to the outside. The exception is EA, where exports of accreditation to the members of APAC, ARAC and IAAC are higher than domestic cross-frontier accreditation activity. This may be explained by the fact that most EA economies have their own accreditation bodies, and several economies have historical relations with their former colonies.



	S/A	EA	IAAC	APAC	AFRAC	ARAC
s/a	0,1%	0,1%	0,0%	0,2%	0,0%	0,0%
EA	1,8%	2,3%	3,7%	4,9%	1,5%	4,3%
IAAC	5,5%	6,9%	12,4%	8,3%	2,4%	6,1%
APAC	0,5%	0,3%	0,3%	4,8%	0,0%	0,8%
AFRAC	1,0%	0,0%	0,0%	0,3%	10,4%	0,6%
ARAC	0,3%	0,9%	0,0%	1,6%	0,0%	3,8%

Table 4: Density of accreditation trade between groups in %

Table 4 also shows the density of accreditation imports (see data in the columns). In the case of IAAC and AFRAC, intra-regional cross-border trade in accreditations clearly dominates. In contrast, APAC and ARAC import more accreditations from IAAC and EA members than from their own RAC. In the case of APAC, it should be considered that several ABs are members of APAC and IAAC at the same time.[22] In the analysis, however, the authors have generally attributed the countries from the Americas to IAAC.

It is also noticeable that EA members import more accreditations from IAAC members than from EA members. This shows the activity of US accreditation bodies in Europe.

[22] ABs from North America (Canada, Mexico and the US) and South America (Peru) are full members and signatories of MLA of APAC and IAAC, see https://www.apac-accreditation.org/membership/ and https://www.iaac.org.mx/index.php/en/members-en/signatarios-de-mla (Retrieved 04/04/2021).

Among the non-signatory countries in any RAC (similarly distributed in America, Africa, and Asia), import relations (the only relevant ones) are especially strong with IAAC and EA. In Table 5 the authors compare the observed values with a random simulation model. The difference between the expected random values and those observed confirms that exports and imports of accreditations are asymmetrical. For example, EA exports 2.31 times more than expected to IAAC, and imports from this RAC 4.33 times more than expected. At the same time, in IAAC and AFRAC (the two RACs with the highest homophily),[23] there are about seven times the number of expected relationships (7.78 and 6.56 times in each case). This confirms the high importance of intra-regional cross-frontier accreditation within both regions.

	S/A	EA	IAAC	APAC	AFRAC	ARAC
s/a	0.04	0.04	0.00	0.11	0	0
EA	1.14	1.47	2.31	3.09	0.93	2.71
IAAC	3.43	4.33	7.78	5.19	1.50	3.84
APAC	0.33	0.21	0.20	2.99	0	0.50
AFRAC	0.65	0	0	0.21	6.56	0.37
ARAC	0.19	0.54	0	1	0	2.38

Number of ties: 337.000 Chi-square: 782.979 Next: 0,002

Table 5: Difference between the observed valued and expected random values[24]

This allows it to be pointed out that there is a correlation of memberships of different RACs (the observed value of chi-square[25] is 782,979, with a significance of 0.002). Although these values are significant, it must be said, however, that as the same level of homophily does not occur in each bloc, the overall probability that the existence of a link can be predicted is low in terms of the general model. To confirm this hypothesis, an Analysis of Variance (ANOVA) model was applied, which performs a regression between the presence/absence of a link between two actors and the membership of the RAC. As a result, it is observed that the differences between blocs express only 3.8% of the variances, although given the significance value (0.0016) it can be stated that this phenomenon is not random, although it does not have the same explanatory value for all cases.

r-square	Adj R-Sqr	Probability	# of obs
0.038	0.036	0.0016	21170

After analysing the influence of membership of the RAC, similar analyses have been carried out for geographical proximity (in this case linked to continental membership),[26] with lower and even less significant values than those presented.[27] Analysing the data in Table 6, the reader will observe that the internal density in the Americas has increased. In the case of Europe, the relatively higher values for accreditation service exports to non-European world regions confirms that they are higher than those within Europe. In the case of Europe and Asia-Pacific, the reader will observe the same pattern of higher extra-regional imports.[28]

[23] Network homophily that similar nodes may be more likely to attach to each other than dissimilar ones. The hypothesis is linked to the model of preferential attachment and it draws from the phenomenon of homophily in the social sciences, and much of the scientific analysis of the creation of social ties based on similarity comes from network science.

[24] For better readability, the authors show the values in Table 5 in absolute terms, contrary to values in percentage as in Table 4 and Table 6.[31] Pace Alves, L. (2013). Triangular Technical Cooperation and the role of INMETRO; In: Austral: Brazilian Journal of Strategy & International Relations, v.2, n.4, Jul-Dec. 2013, p.117-139

[25] The chi-squared statistic is a single number that tells how much difference exists between the observed counts and the counts one would expect if there were no relationship at all in the population. The chi-square value in Table 5 indicates a strong relationship.

[26] The authors have assumed that the countries not associated with an RAC relate to it based on their continental location.

[27] However, in general the values of this type of test are low, since in a matrix of relationships the probability of the existence/absence of a relationship between them is linked to the number of nodes (in this case 146 economies).

[28] To analyse the differences between the three partitions used, the values of the E-I index can be seen, which reflects the proportion of internal and external links between groups, with an indicator ranging from 1 to -1, the latter value being that of maximum encapsulation. It can be seen that using a totally inductive method, 80.8% of the relations are given within each group (E-I: -0.62); if the membership of the RAC is analysed, the figure for internal relations falls to 26.6% (E-I 467), and if the geographical proximity is considered, the relations reach 40% (E-I 195, although it should be considered as that with fewer groups).

	EA+	IAAC+	APAC+	AFRAC+	ARAC
EA+Europe	1,8%	1,7%	3,1%	1,9%	3,6%
IAAC+Americas	2,9%	4,6%	3,0%	1,1%	2,7%
APAC+Asia+Oceania	0,2%	0,1%	2,4%	0,0%	0,5%
AFRAC+Africa	0,0%	0,0%	0,1%	3,2%	0,3%
ARAC	0,7%	0,0%	1,2%	0,3%	3,8%

Table 6: Densities of membership of the RAC by continental membership in %

TYPOLOGY OF ECONOMIES REGARDING THEIR CROSS-FRONTIER ACCREDITATION

General typology of cross-frontier accreditation economies

So far we have analysed the economies mainly in their regional context. In this chapter, the authors will look at different types of economies in terms of their cross-frontier accreditation activity. To this end, the authors have identified five types of accreditation trade economies:

(1) Only importers: economies which do not provide and only import accreditation services
(2) Importing providers: economies which provide accreditation services but import more than they provide by the local AB
(3) Exporting importers: economies which import more accreditation services than they export
(4) Importing exporters: economies which export more accreditation services than they import
(5) Only exporters: economies which export and do not import accreditation services

TYPE	NUMBER OF ECONOMIES	SHARE OF ECONOMIES WITH OWN AB	MEMBERS OF RAC	AFFILIATION OF SERVICE PROVIDERS	ECONOMIES OF THIS TYPE (EXAMPLES)
Only importer	34	3%	0	IAAC, APAC, AFRAC	AFG, LIE, UGA
Importing providers	23	100%	65%	AFRAC, ARAC (less IAAC)	QAT, ARE, SAU
Exporting importers	72	100%	80%	EA, APAC, IAAC	TUR, CHL, MEX, CAN, CHN, IND, JPN, TWN, KOR
Importing exporters	15	100%	100%	EA, IAAC	NLD, BEL, GRC, DEU, GBR, FRA, USA, CRI, JAM, SLV, AUS, KAZ, KEN, ZAF, EGY
Only exporters	2	100%	100%		PRT, BWA

Table 7 describes the type-specific characteristics of the economies:

- Group 1 "Only Importers" comprises 34 economies of which only 3% have their own ABs. Economies in this group are not signatories to or members of an RAC, and import accreditation services from ABs that are members of IAAC, APAC or AFRAC.
- Group 2 "Importing providers" counts 23 economies which, like all the following groups, all have at least one AB in the country. 65% of the importing providers are members of RAC, especially AFRAC and ARAC, and to a lesser extent IAAC. Qatar (QAT), United Arab Emirates (ARE) and Saudi Arabia (SAU) stand out among the importing providers.

- Group 3 "Exporting Importers" comprises 72 countries, 80% of which are members of an RAC. They include Turkey (TUR), Chile (CHL), Mexico (MEX), Canada (CAN), China (CHN), India (IND), Japan (JPN), Taiwan (TWN) and Korea (KOR).
- Group 4 "Importing exporters" comprises 15 countries including The Netherlands (NLD), Belgium (BEL), Greece (GRC), Germany (DEU), the United Kingdom (GBR), France (FRA), the United States (USA), Costa Rica (CRI), Jamaica (JAM), El Salvador (SLV), Australia (AUS), Kazakhstan (KAZ), Kenya (KEN), South Africa (ZAF) and Egypt (EGY).
- Group 5 "Only exporters" includes Portugal and Botswana (as SADCAS headquarters).

Typology of accreditation service exporters

By linking the centrality analysis and the existence of blocs explained in Section 3.3, the reader can see the relationship patterns of the main countries that trade accreditation services. The authors carried out a heterogeneity[29] analysis which allows three profiles among exporters to be identified:[30]

(1) The first group includes the most diversified economies, which export to most of the blocs mentioned above (including countries not affiliated with any association). In no case do their relations with a bloc exceed 45%. This is the case of Germany (DEU), The Netherlands (NLD), Turkey (TUR), Greece (GRC), United Kingdom (GBR) (all members of EA), Canada (CAN) and the United States (USA) (members of IAAC); Egypt (EGY) (member of ARAC) and Kenya (KEN) (member of AFRAC) can be added.

(2) The second profile of moderate diversification includes five economies that have relations with only three blocs or concentrate 60% of their connections in one of them. This is the case of France (FRA) in EA; Brazil (BRA) and Mexico (MEX) in IAAC, and Australia (AUS) and Kazakhstan (KAZ) in APAC.

(3) The rest of the cases (18 economies) are heavily concentrated in one or two blocs. Two major African exporters, South Africa (ZAF) and Botswana (BWA), stand out among them, as do most American exporters (which reinforces what was said earlier when analysing relations between blocs).

If the authors include exports and imports in this heterogeneity analysis, further economies can be assigned to the three types:[31]

(1) The first and most diversified group includes 15 economies that are linked to most of the aforementioned blocs (including countries that are not affiliated to any RAC) and in no case do their relations with a bloc exceed 45%. By integrating all relations, this group not only includes countries from EA (Germany (DEU), The Netherlands (NLD), Turkey (TUR), Greece (GRC) and the United Kingdom (GBR)), but also from APAC (China (CHN), Malaysia (MYS), Kazakhstan (KAZ), Hong Kong (HKG) and India (IND) and to a lesser extent IAAC (Canada (CAN), United States (USA); ARAC (Egypt (EGY), United Arab Emirates (ARE)) and AFRAC (Kenya (KEN)).

(2) The second moderately diversified group includes 25 economies that have relations with only three blocs or that concentrate 60% or more of their relations in a single bloc. The economies of APAC (Thailand (THA), Singapore (SGP), Philippines (PHL), Korea (KOR), Japan (JPN), EA (Belgium (BEL), Georgia (GEO), France (FRA), Italy (ITA), AFRAC (Angola (AGO), Ethiopia (ETH), South Africa (ZAF)) and ARAC (Kuwait (KWT), Saudi Arabia (SAU), Qatar (QAT)) stand out, although also those of IAAC (Brazil (BRA) and Mexico (MEX)) and non-signatory countries such as Azerbaijan (AZE), Uganda (UGA), Ghana (GHA), Trinidad and Tobago (TTO), Lebanon (LBN), Nigeria (NGA) and Congo (COG).

(3) The rest of the cases (106 economies) are heavily concentrated in one or two blocs, including 48 non-signatory economies, 20 from Europe, 11 from the Americas, ten from Asia-Pacific, ten from Africa and seven from the Arab countries.

[29] The Blau Index of Heterogeneity is 1 minus the sum of the squares of the proportions of each value of the categorical variable in the ego network. For example, an economy connected to an equal number of economies in each bloc will have a measure of heterogeneity of 0.5, calculated as 1 - ((1/2) ^2 + (1/2) ^ 2)). The IQV or Index of Qualitative Variation is a standardised version of this index and is equal to the previous column divided by 1-1 /n.

[30] The reader will find the data from this analysis in Annexure 3.

[31] The reader will find the data from this analysis in Annexure 4.

4

CONCLUSIONS

This study is the first to address the phenomenon of cross-frontier accreditation based on empirical data.

Accreditation is the formal attestation of the independence and technical competence of a conformity assessment body. Accreditations are a central instrument for building trust in international trade and a constitutive part of the global quality infrastructure.

In principle, accreditation takes place predominantly within a national framework. In the European Union, for example, the principle "one accreditation body per country" strictly applies, but in other parts of the world we usually find only one AB per country. Important exceptions are the United States, India, Korea and Japan with several domestic ABs.

Those responsible for the international and regional accreditation communities assume that competition between ABs would lead to inefficient duplication and negative effects on transparency in the global accreditation system. In this respect, cross-border accreditation services are well-defined narrow limits.

Cross-frontier accreditation makes sense whenever conformity assessment bodies do not find a suitable range of accreditation services in a country. This applies to developing and emerging countries that either do not yet have their own accreditation body or whose range of services is not yet comprehensively recognised internationally. In these cases, it is quite helpful if a foreign AB accredits local test and calibration laboratories or certification bodies. The foreign ABs should collaborate closely with the responsible bodies in the target country, including the National Accreditation Focal Points (NAFP).

Based on figures for 2020, the empirical analysis shows that currently 2,078 accreditations for CABs were issued by foreign ABs. Concerning the total number of 108,208 accreditations worldwide, the share of cross-frontier accreditations accounts for 2.7% of all accreditations. Even if the share of the total number of accreditations is relatively low, the significance is considerable, especially for smaller developing countries whose quality infrastructure is in an initial development phase. For the NAFP country, the input of the experienced partner is an important impetus to competently build up its own QI. A first result of this study is that the export of accreditation services is concentrated in a few countries. The ABs of the United States alone represent 64% of all exported accreditations. Among the top ten exporters are European countries (Germany, the UK, The Netherlands and France), Australia, Canada, South Africa and Botswana (host country of the SADCAS Secretariat). Overall, these countries account for 91% of all cross-frontier exports of accreditations. The distribution of imports is more dispersed. Due to its size, it is surprising that China accounts for 13% of all imported accreditations.

Hong Kong accounts for an additional 2%. Other populous countries such as India, the USA and Russia are also among the larger importers of accreditation services. Other top ten importers of accreditation are Japan, Peru, Egypt, Chile and the United Arab Emirates. All these countries have local ABs, and industrialised and emerging countries are dominating. Together they represent 37% of all imported accreditation services.

Using social network analysis, the authors of this study examined the patterns of cross-frontier accreditation. The analysis of the relationship patterns shows a dominant bloc of 93 economies (64% of the total) that are influenced by the strength of the United States. Smaller blocs appear around the sub-regional integration systems in Central America and the Caribbean and in Southern Africa. Relationships between France and some Francophone countries in Africa are also evident. Less explicable is the group of accreditation partners, led by Greece and Kazakhstan, stretching from the Eastern Mediterranean to Mongolia.
The accreditation analysis within the different RACs shows that for IAAC, APAC, AFRAC and ARAC, the cross-frontier accreditation exports are predominantly within the region. In contrast, EA members with cross-frontier exports are more outside their continent than in Europe. The authors explain that this is because almost all European countries have very developed ABs of their own: the one-country-one-AB principle applies, and traditionally there are close relations with less developed countries in Africa, Latin America and the Caribbean.

Conversely, in the case of imports of accreditation services, it is evident that the economies in the IAAC and AFRAC spheres of influence import more accreditation services from countries in their region and other regions. In the case of IAAC, this again shows the strong presence of accreditation bodies from the USA in Latin America and the Caribbean. The European accreditation bodies, which were strongly represented until the early 2000s, are less present in the IAAC area today.

The study concludes with a typology of economies in terms of their cross-frontier accreditation patterns: Only two economies are "Only exporters" of accreditations. The largest group are the "Exporting importers" – 72 economies import more accreditation services than they export. In contrast, 15 "Importing exporters" export more accreditation services than they import. The authors describe 23 economies as "Importing providers", which have their own ABs but nevertheless import more accreditation services than they export. Finally, there is the group of "Only importers", which exclusively purchase accreditation services from abroad.

Finally, the economies whose ABs operate cross-frontier accreditations can be differentiated in terms of trade relations with various RACs. A group of 15 economies is most diversified; 25 are moderately diversified and the remaining 106 concentrate their cross-border accreditation activities on service providers from only one or two world regions.

5

THE WAY FORWARD

This study substantiates the knowledge of cross-frontier accreditation with empirical data for the first time. The analysis of the data shows different patterns in cross-frontier accreditation. The results require interpretation by the actors of the accreditation community itself. For example, it can be asked whether the practice depicted is in line with the objectives of the ILAC and IAF guidelines. There is a need for further research on how the development process of a NAB can best be accompanied and supported by cross-border activities. Possible conflicts of interest between local ABs, foreign ABs and local users should be considered.

The study points out the particular importance of RACs. They can accompany the intraregional accreditation activities, but also coordinate with the other RACs regarding extra-regional cross-border accreditation. ILAC and IAF could offer a suitable forum here.

The data sets that the authors have collected can be evaluated in more detail. For example, they could be analysed by ABs rather than by country and region alone. Also, a distinction could be made between different types of accreditation, e.g., accreditations for certification or laboratories.

Finally, the authors suggest that international and regional accreditation cooperations should systematically and regularly collect and publish data on cross-border accreditation. Such a practice could improve data quality, increase transparency, and enable observation of development over time.

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TERM	DEFINITION
Accreditation	Third-party attestation related to a conformity assessment body conveying formal demonstration of its competence to carry out specific conformity assessment tasks
Accreditation body	An authoritative body that performs accreditation
Attestation	Issue of a statement, based on a decision following review, that fulfilment of specified requirements has been demonstrated
Calibration	Operation that establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, uses this information to establish a relation for obtaining a measurement result from an indication. Accredited calibration certificates may only be issued by calibration and test laboratories whose expertise to carry out calibrations according to ISO/IEC 17025 has been recognized.
Conformity assessment	demonstration that specified requirements relating to a product, process, system or body are fulfilled.
Conformity assessment body	A body that performs conformity assessment
Cross-frontier accreditation	An exceptional case when a conformity assessment body or a calibration laboratory applies for accreditation from a body outside its country (economy)
Foreign accreditation body	When an accreditation body accredits a conformity assessment body with activities in another country
Local accreditation body	Accreditation body of a country where there is a location(s) where conformity assessment activities take place that are included in an accreditation granted by an accreditation body in another country.
Multilateral arrangement	Arrangement whereby more than two parties recognise or accept one another's conformity assessment results
National accreditation focal point	Organisation in an economy without a national accreditation body, to inform local users about internationally recognised conformity assessment and accreditation services abroad.
Peer evaluation	Assessment procedure regarding the conformity of the accreditation body with the requirements of the corresponding standard recognized evaluators and technical experts (peers). Peer evaluators and technical experts undertake peer evaluation of accreditation bodies who participate in Mutual Recognition Arrangements (MRAs).
Third-party assessment activity	Conformity assessment activity that is performed by a person o body that is independent of the person or organisation that provides the object, and of user interest in that object
Verification	Confirmation of a claim, through the provision of objective evidence, that specified requirements have been fulfilled

Annexure 1: Definitions

References: ISO, PTB, and own definitions

[32] https://www.iso.org/obp/ui/#iso:std:iso-iec:17000:ed-1:v1:en

[33] https://www.ptb.de/cms/fileadmin/internet/fachabteilungen/abteilung_9/9.3_internationale_zusammenarbeit/publikationen/PTB_Info_NAFP_EN_02.pdf

The following is a complete ISO 3166-1 encoding list of the countries/economies which have been assigned official codes. The list is in alphabetical order according to the country's English short name used by ISO 3166/MA.

ABW Aruba	DNK Denmark	LAO Lao People's Democratic Republic	QAT Qatar
AFG Afghanistan	DOM Dominican Republic	LBN Lebanon	REU Réunion
AGO Angola	DZA Algeria	LBR Liberia	ROU Romania
AIA Anguilla	ECU Ecuador	LBY Libya	RUS Russian Federation
ALA Åland Islands	EGY Egypt	LCA Saint Lucia	RWA Rwanda
ALB Albania	ERI Eritrea	LIE Liechtenstein	SAU Saudi Arabia
AND Andorra	ESH Western Sahara	LKA Sri Lanka	SDN Sudan
ARE United Arab Emirates	ESP Spain	LSO Lesotho	SEN Senegal
ARG Argentina	EST Estonia	LTU Lithuania	SGP Singapore
ARM Armenia	ETH Ethiopia	LUX Luxembourg	SGS South Georgia and the South Sandwich Islands
ASM American Samoa	FIN Finland	LVA Latvia	SHN Saint Helena, Ascension and Tristan da Cunha
ATA Antarctica	FJI Fiji	MAC Macao	SJM Svalbard and Jan Mayen
ATF French Southern Territories	FLK Falkland Islands (Malvinas)	MAF Saint Martin (French part)	SLB Solomon Islands
ATG Antigua and Barbuda	FRA France	MAR Morocco	SLE Sierra Leone
AUS Australia	FRO Faroe Islands	MCO Monaco	SLV El Salvador
AUT Austria	FSM Micronesia (Federated States of)	MDA Moldova, Republic of	SMR San Marino
AZE Azerbaijan	GAB Gabon	MDG Madagascar	SOM Somalia
BDI Burundi	GBR United Kingdom of Great Britain and Northern Ireland	MDV Maldives	SPM Saint Pierre and Miquelon
BEL Belgium	GEO Georgia	MEX Mexico	SRB Serbia
BEN Benin	GGY Guernsey	MHL Marshall Islands	SSD South Sudan
BES Bonaire, Sint Eustatius and Saba	GHA Ghana	MKD North Macedonia	STP Sao Tome and Principe
BFA Burkina Faso	GIB Gibraltar	MLI Mali	SUR Suriname
BGD Bangladesh	GIN Guinea	MLT Malta	SVK Slovakia
BGR Bulgaria	GLP Guadeloupe	MMR Myanmar	SVN Slovenia
BHR Bahrain	GMB Gambia	MNE Montenegro	SWE Sweden
BHS Bahamas	GNB Guinea-Bissau	MNG Mongolia	SWZ Eswatini
BIH Bosnia and Herzegovina	GNQ Equatorial Guinea	MNP Northern Mariana Islands	SXM Sint Maarten (Dutch part)
BLM Saint Barthélemy	GRC Greece	MOZ Mozambique	SYC Seychelles
BLR Belarus	GRD Grenada	MRT Mauritania	SYR Syrian Arab Republic
BLZ Belize	GRL Greenland	MSR Montserrat	TCA Turks and Caicos Islands
BMU Bermuda	GTM Guatemala	MTQ Martinique	TCD Chad

BOL Bolivia (Plurinational State of)	GUF French Guiana	MUS Mauritius	TGO Togo
BRA Brazil	GUM Guam	MWI Malawi	THA Thailand
BRB Barbados	GUY Guyana	MYS Malaysia	TJK Tajikistan
BRN Brunei Darussalam	HKG Hong Kong	MYT Mayotte	TKL Tokelau
BTN Bhutan	HMD Heard Island and McDonald Islands	NAM Namibia	TKM Turkmenistan
BVT Bouvet Island	HND Honduras	NCL New Caledonia	TLS Timor-Leste
BWA Botswana	HRV Croatia	NER Niger	TON Tonga
CAF Central African Republic	HTI Haiti	NFK Norfolk Island	TTO Trinidad and Tobago
CAN Canada	HUN Hungary	NGA Nigeria	TUN Tunisia
CCK Cocos (Keeling) Islands	IDN Indonesia	NIC Nicaragua	TUR Turkey
CHE Switzerland	IMN Isle of Man	NIU Niue	TUV Tuvalu
CHL Chile	IND India	NLD Netherlands	TWN Taiwan, Province of China
CHN China	IOT British Indian Ocean Territory	NOR Norway	TZA Tanzania, United Republic of
CIV Côte d'Ivoire	IRL Ireland	NPL Nepal	UGA Uganda
CMR Cameroon	IRN Iran (Islamic Republic of)	NRU Nauru	UKR Ukraine
COD Congo, Democratic Republic of the	IRQ Iraq	NZL New Zealand	UMI United States Minor Outlying Islands
COG Congo	ISL Iceland	OMN Oman	URY Uruguay
COK Cook Islands	ISR Israel	PAK Pakistan	USA United States of America
COL Colombia	ITA Italy	PAN Panama	UZB Uzbekistan
COM Comoros	JAM Jamaica	PCN Pitcairn	VAT Holy See
CPV Cabo Verde	JEY Jersey	PER Peru	VCT Saint Vincent and the Grenadines
CRI Costa Rica	JOR Jordan	PHL Philippines	VEN Venezuela (Bolivarian Republic of)
CUB Cuba	JPN Japan	PLW Palau	VGB Virgin Islands (British)
CUW Curaçao	KAZ Kazakhstan	PNG Papua New Guinea	VIR Virgin Islands (U.S.)
CXR Christmas Island	KEN Kenya	POL Poland	VNM Viet Nam
CYM Cayman Islands	KGZ Kyrgyzstan	PRI Puerto Rico	VUT Vanuatu
CYP Cyprus	KHM Cambodia	PRK Korea (Democratic People's Republic of)	WLF Wallis and Futuna
CZE Czechia	KIR Kiribati	PRT Portugal	WSM Samoa
DEU Germany	KNA Saint Kitts and Nevis	PRY Paraguay	YEM Yemen
DJI Djibouti	KOR Korea, Republic of	PSE Palestine, State of	ZAF South Africa
DMA Dominica	KWT Kuwait	PYF French Polynesia	ZMB Zambia
			ZWE Zimbabwe

Annexure 2: Country Codes

	RAC	NUMBER OF EXPO PERFORMANCES	HETEROGENEITY	IQV	S/A	EA	IAAC	APAC	AFRAC	ARAC
DEU	EA	143	0,81	0,97	0,21	0,18	0,18	0,26	0,05	0,13
CAN	IAAC	36	0,79	0,95	0,27	0,27	0,13	0,20	0,07	0,07
USA	IAAC	1848	0,78	0,94	0,31	0,22	0,12	0,21	0,03	0,10
NLD	EA	27	0,78	0,93	0,21	0,14	0,07	0,36	0,14	0,07
EGY	ARAC	57	0,72	0,87	0,14	0,21	0,00	0,29	0,00	0,36
GRC	EA	51	0,72	0,86	0,25	0,38	0,00	0,13	0,00	0,25
TUR	EA	23	0,72	0,86	0,40	0,20	0,00	0,20	0,00	0,20
KEN	AFRAC	19	0,72	0,86	0,40	0,00	0,00	0,20	0,20	0,20
GBR	EA	73	0,70	0,84	0,05	0,10	0,15	0,45	0,00	0,25
KAZ	APAC	10	0,67	0,80	0,00	0,33	0,00	0,33	0,33	0,00
BRA	IAAC	9	0,67	0,80	0,33	0,33	0,00	0,33	0,00	0,00
FRA	EA	59	0,58	0,70	0,62	0,08	0,00	0,15	0,08	0,08
MEX	IAAC	43	0,58	0,70	0,20	0,10	0,60	0,10	0,00	0,00
AUS	APAC	207	0,54	0,65	0,15	0,05	0,05	0,65	0,00	0,10
HKG	APAC	12	0,50	0,60	0,50	0,00	0,00	0,50	0,00	0,00
BEL	EA	3	0,50	0,60	0,50	0,00	0,00	0,50	0,00	0,00
TTO	0	2	0,50	0,60	0,50	0,50	0,00	0,00	0,00	0,00
ZAF	AFRAC	65	0,47	0,57	0,38	0,00	0,00	0,00	0,62	0,00
ESP	EA	12	0,45	0,54	0,14	0,14	0,71	0,00	0,00	0,00
LRC	IAAC	19	0,44	0,53	0,67	0,00	0,33	0,00	0,00	0,00
CHN	APAC	16	0,44	0,53	0,33	0,00	0,00	0,67	0,00	0,00
ITA	EA	11	0,44	0,53	0,00	0,33	0,67	0,00	0,00	0,00
ARG	IAAC	8	0,44	0,53	0,00	0,67	0,00	0,33	0,00	0,00
PRT	EA	4	0,38	0,45	0,75	0,00	0,00	0,00	0,25	0,00
BWA	AFRAC	82	0,17	0,20	0,09	0,00	0,00	0,00	0,91	0,00
TWN	APAC	15	0	0	0,00	0,00	1,00	0,00	0,00	0,00
JAM	IAAC	13	0	0	1,00	0,00	0,00	0,00	0,00	0,00
CHL	IAAC	3	0	0	0,00	0,00	1,00	0,00	0,00	0,00
UZB	0	3	0	0	0,00	0,00	0,00	1,00	0,00	0,00
SLV	IAAC	2	0	0	0,00	0,00	0,00	1,00	0,00	0,00
ECU	IAAC	2	0	0	0,00	1,00	0,00	0,00	0,00	0,00
VIC	0	1	0	0	1,00	0,00	0,00	0,00	0,00	0,00
SLV	IAAC	2	0	0	0,00	0,00	0,00	1,00	0,00	0,00
ECU	IAAC	2	0	0	0,00	1,00	0,00	0,00	0,00	0,00
VIC	0	1	0	0	1,00	0,00	0,00	0,00	0,00	0,00

Annexure 3: Relationship patterns of countries regarding accreditation services exports

Note: Ordered by heterogeneity

	RAC	NUMBER OF EXPO PERFORMANCES	AMOUNT SERVICES	HETEROGENEITY	IQV	S/A	EA	IAAC	APAC	AFRAC	ARAC
KEN	AFRAC	19	18	18	0,81	0,98	0,22	0,22	0,11	0,11	0,22
DEU	EA	143	34	34	0,81	0,97	0,20	0,18	0,20	0,25	0,05
NLD	EA	27	6	6	0,80	0,96	0,19	0,19	0,13	0,31	0,13
CAN	IAAC	36	235	235	0,80	0,96	0,25	0,25	0,19	0,19	0,06
USA	IAAC	1848	61	61	0,78	0,94	0,31	0,22	0,12	0,21	0,03
TUR	EA	23	58	58	0,78	0,94	0,25	0,13	0,13	0,25	0,00
EGY	ARAC	57	21	21	0,78	0,93	0,12	0,24	0,12	0,24	0,00
GRC	EA	51	5	5	0,77	0,92	0,22	0,33	0,11	0,11	0,00
CHN	APAC	16	379	379	0,77	0,92	0,14	0,29	0,21	0,29	0,00
MYS	APAC	0	40	40	0,72	0,86	0,00	0,40	0,20	0,20	0,00
KAZ	APAC	10	2	2	0,72	0,86	0,20	0,40	0,20	0,20	0,00
ARE	ARAC	0	72	72	0,72	0,86	0,00	0,40	0,20	0,20	0,00
GBR	EA	73	20	20	0,70	0,84	0,05	0,10	0,15	0,45	0,00
HKG	APAC	12	47	47	0,69	0,83	0,14	0,14	0,29	0,43	0,00
IND	APAC	0	207	207	0,69	0,82	0,00	0,50	0,13	0,13	0,13
LBN		0	18	18	0,67	0,80	0,00	0,33	0,33	0,00	0,00
NGA		0	22	22	0,67	0,80	0,00	0,00	0,33	0,00	0,33
COG		0	6	6	0,67	0,80	0,00	0,33	0,33	0,00	0,33
BEL	EA	3	2	2	0,67	0,80	0,33	0,33	0,00	0,33	0,00
GEO	EA	0	6	6	0,67	0,80	0,00	0,33	0,33	0,33	0,00
FRA	EA	59	11	11	0,67	0,80	0,53	0,13	0,07	0,13	0,07
BRA	IAAC	9	17	17	0,67	0,80	0,00	0,17	0,50	0,17	0,17
THA	APAC	0	26	26	0,67	0,80	0,00	0,33	0,33	0,33	0,00
QAT	ARAC	0	34	62	0,56	0,67	0,00	0,60	0,20	0,20	0,00
GSP	APAC	0	34	34	0,67	0,80	0,00	0,00	0,33	0,33	0,00
PHL	APAC	0	9	9	0,67	0,80	0,00	0,33	0,33	0,33	0,00
AUG	AFRAC	0	5	5	0,67	0,80	0,00	0,33	0,33	0,00	0,33
ETH	AFRAC	0	5	5	0,67	0,80	0,00	0,33	0,33	0,00	0,33
KWT	ARAC	0	32	32	0,67	0,80	0,00	0,33	0,33	0,00	0,00
ITA	EA	11	26	26	0,64	0,77	0,00	0,40	0,40	0,20	0,00
KOR	APAC	0	76	76	0,64	0,77	0,00	0,40	0,40	0,20	0,00
MEX	IAAC	43	142	142	0,63	0,75	0,18	0,18	0,55	0,09	0,00
AZE		0	7	7	0,63	0,75	0,00	0,50	0,25	0,25	0,00
UGA		0	20	20	0,63	0,75	0,00	0,25	0,25	0,00	0,50
GHA		0	17	17	0,63	0,75	0,00	0,25	0,50	0,00	0,25
UAA	ARAC	0	118	118	0,63	0,75	0,00	0,50	0,25	0,00	0,00
ZAF	AFRAC	65	12	12	0,60	0,71	0,33	0,07	0,07	0,00	0,53
AUS	APAC	207	15	15	0,58	0,69	0,14	0,05	0,10	0,62	0,00
JPN	APAC	0	145	145	0,57	0,69	0,00	0,57	0,14	0,29	0,00
TTO		2	9	9	0,56	0,67	0,20	0,20	0,60	0,00	0,00
QAT	ARAC	0	62	62	0,56	0,67	0,00	0,60	0,20	0,20	0,00

Annexure 4: Relationship patterns of countries regarding accreditation services imports

Note: Ordered by heterogeneity

Annexure 5: Case history: Colombia

Colombia is an excellent example of a still young National Accreditation Body (NAB) that has made significant progress in its international recognition in recent years.

The National Accreditation Body of Colombia, ONAC, is a non-profit corporation governed by private law, established in 2007 and organised by statutory provision under Colombian law within the framework of the Civil Code and the rules on science and technology.

ONAC has been the National Accreditation Body of Colombia since 2008. In that year, the public administrative nature of accreditation was abolished, and its technical nature was fully recognised. ONAC's main purpose is to accredit the technical competence of Conformity Assessment Bodies, to act as a monitoring authority in good laboratory practices of the Organisation for Economic Co-operation and Development (OECD) and to perform the functions of the National Accreditation Body of Colombia, in accordance with the designation contained in Chapter 26 of Decree 1074 of 2015 of Ministry of Commerce, Industry and Tourism of Colombia.

Since 2015 ONAC's technical competence has been recognised internationally by being a signatory to Multilateral Recognition Agreements:

In the IAF area, ONAC signed the first MRAs on 6.10.2015 in Product Certification – ISO/IEC 17065 and Management Systems Certification – ISO/IEC 17021-1.

In the ILAC area, ONAC signed MRAs for Accreditations for Testing and Calibration Laboratories on 7.4.2014. This was followed by the signing of MRAs for Proficiency Testing Providers to IS0/IEC 17043(19/09/2019) and Medical Testing to ISO 15189 (26/06/2020).

According to GQII, in 2020 ONAC had accredited 230 testing laboratories, 183 calibration laboratories, five clinical laboratories, two proficiency testing providers, as well as 37 product certification bodies, 15 QMS, 12 EMS, two FSMS, five ISMS, one MDMS, one EnMS and 12 OHSMS, 28 personnel certification and one greenhouse gas validation and verification certification bodies, among others. Most of these conformity assessment bodies are based in Colombia. Abroad, ONAC had accredited a testing laboratory in Venezuela and two product certification bodies in Mexico and Peru.

In contrast, 2020 foreign accreditation bodies had accredited the following Colombian CABs: five testing laboratories, three calibration laboratories, one product certification body, two proficiency testing providers and one reference material producer.

Accreditation Services: Imports

Accreditation Services: Exports

Source: GQII data base

According to confidential information from ONAC, after signing the IAF-MLA and ILAC-MRA respectively, one calibration laboratory and one certification body for QMS switched from a foreign provider to accreditation by the national accreditation body.

ONAC officials emphasise that it is the CABs alone that decide which service provider to use for accreditation. A CAB has the right to request voluntary withdrawal of accreditation and to initiate a new accreditation procedure with another AB.

CABs can wait for their accreditation to expire and not renew it and initiate an accreditation process with another AO. CABs may also consider seeking accreditation from two ABs.

In addition to the provisions of the MLA, the ABs also use Memorandum of Understanding (MoU) to define their cooperation.

The MoUs regulate the exchange of information, technology and experts between the accreditation bodies. At the same time, they strengthen the mutual recognition of accreditation results. ONAC has signed two MoUs with foreign ABs so far, and MoUs are currently in preparation.

GQII

GLOBAL QUALITY INFRASTRUCTURE INDEX

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