ISSN: 1576-0162
DOI: http://dx.doi.org/10.33776/rem.vi64.7161

How Did the 2008 Economic Crisis Affect Central Banks' Research Topics? The Case of CEMLA Associates and Collaborating Member

¿Cómo afectó la crisis económica de 2008 a los temas de investigación de los bancos centrales? El caso de los asociados y colaboradores del CEMLA

María Luísa Lascurain-Sánchez
Research Institute for Higher Education and Science (INAECU)
Autonomous University of Madrid (UAM)
Carlos III University of Madrid (UC3M)
mlascura@bib.uc3m.es

Núria Bautista-Puig
Complutense University of Madrid (UCM)
nuriabau@ucm.es

Elena López-de-la-Fuente
Bank of Spain. Library *
mlopez@bde.es

Elías Sanz-Casado
Research Institute for Higher Education and Science (INAECU)
Autonomous University of Madrid (UAM)
Carlos III University of Madrid (UC3M)
elias@bib.uc3m.es

Recibido: junio 2022; aceptado: junio 2023

Abstract

Central banks play a fundamental role in a country's monetary policy. This study has a twofold objective: a) to analyse the contribution to academic research made by the associates and collaborating members of the Center for Latin American Monetary Studies (CEMLA) and b) to analyse the evolution of research topics in the economic literature over the without economic crisis and with crisis. Eighteen banks were subjected to bibliometric analysis covering the

* The views expressed in this paper are those of the authors and do not necessarily coincide with those of the Bank of Spain or the Eurosystem.

period 2000-2019. The results show that, although the number of publications is higher for the collaborating members, the growth rate over time is higher in the associates. Associates collaborate less with other institutions in the crisis period than collaborating members. The evolution of topics reveals important differences between the two groups.

Keywords: CEMLA, CEMLA associates, CEMLA collaborating members, scientization, economic literature, bibliometrics.

Resumen

Los bancos centrales juegan un papel fundamental en la política monetaria de un país. Este estudio tiene un doble objetivo: a) analizar la contribución a la investigación académica realizada por los miembros asociados y colaboradores del Centro de Estudios Monetarios Latinoamericanos (CEMLA) y b) analizar la evolución de los temas de investigación en la literatura económica a lo largo del período sin crisis y con crisis. Dieciocho bancos fueron sometidos a análisis bibliométrico cubriendo el período 2000-2019. Los resultados muestran que, aunque el número de publicaciones es mayor para los miembros colaboradores, la tasa de crecimiento en el tiempo es mayor en los asociados. Los asociados colaboran menos con otras instituciones en periodo de crisis que los miembros colaboradores. La evolución de los temas revela diferencias importantes entre los dos grupos.

Palabras clave: CEMLA, asociados del CEMLA, miembros colaboradores del CEMLA, cientificación, literatura económica, bibliometría.

JEL Classification / Clasificación JEL: A10, C00, E58, G01, O57, F0.

1. Introduction

According to the definition by the European Central Bank (2015),[1] "a central bank is a public institution that manages the currency of a country or group of countries and controls the money supply – literally, the amount of money in circulation. The main objective of many central banks is price stability." In addition to performing functions related with monetary policy, which focuses on keeping prices stable through controlling inflation, central banks usually have powers over the stability of the financial system and its supervision, foreign currency reserves and currency issues, depending on the underlying legal texts defining each bank (laws, or treaties in the case of supranational institutions). Central banks also prepare high-quality, reliable statistics on the financial system. In addition, some, like the U.S. Federal Reserve System, have a mandate to support full employment; some, as in the case of the central banks of Argentina, Paraguay and Venezuela, are tasked with supporting economic development (Schmidt-Hebbel and Carrasco, 2019).

Since the mid-20th century, central banks have increasingly relied on economic science. They have encouraged research, which provides the theoretical and empirical foundations they need to comply with their remit. The results of their research have been incorporated into the policy-formulating process and the evaluation of policy results. As Eijffinger et al (2002) state, the different kinds of research that central banks conduct equip them with different perspectives, which are of inestimable value for dealing with an increasingly complex economy. All these advances are contributing to the modernization of central banks, which more and more is linked to bank "scientization". Central bank scientization goes beyond the political arena. It enables institutions to bring on board scientific experts in financial and monetary areas, thus vesting central banks with scientific authority, based on the use of new terminology, new forms of communication and the assignment of greater resources to research. The production of high-quality scientific papers as the result of research into economics and related disciplines is one of the main indicators of the bank "scientization" process (Marcussen, 2006; 2009), which has turned banks into pacesetting scientific institutions in matters of monetary and financial policy and macroeconomic modelling.

1 https://www.ecb.europa.eu/ecb/educational/explainers/tell-me/html/what-is-a-central-bank.en.html

The publication of research findings in different formats (reports, notes, lectures, papers in scientific journals) usually has a strong repercussion and helps enhance a central bank's credibility and reputation (Eijffinger et al, 2002; Uribe Escobar, 2008; Sarmiento, 2010; Claveau and Dion, 2018). Scientific output and its dissemination are swayed by a great many factors. One of the most frequently analysed factors is the possible influence of bank size. Another is the proportion of researchers compared to the bank's total number of employees; mixed conclusions are found on this point, leading to both a positive correlation between size and scientific output and the contrasting notion that researchers at smaller central banks tend to be more productive (Eijffinger et al, 2002; Eijffinger, 2003; Angelini, 2003; Jondeau and Pagès, 2003; Sarmiento, 2010).

Jondeau and Pagès (2003) highlight an additional component to consider in central bank research: the bank's own culture and institutional tradition, which determine the structure and the importance of where and how research is done. As Gaspar and Vega (2002) assert, scientific activity at banking institutions of this sort is not necessarily concentrated into a single autonomous organizational unit but may instead be spread out over various areas or departments. Frequently nowadays banks have specific research departments or directorates, although they may have research done in other departments as well. Institutional policies on publication are generally a decisive factor. Central banks customarily share their research efforts by releasing series of working papers or research papers, which may be published in peer-reviewed journals later. Moreover, in some central banks publication policy affects both research topics and spheres of publication for work done in collaboration with similar institutions through formal networks (such as the Central Bank Research Association, CEBRA[2]) or academic institutions to favour knowledge synergies and expand the research scope (St-Amant et al., 2005; Sarmiento, 2010).

Analysis of banks' scientific activity enables classifications to be created, like RePEc's[3] IDEAS,[4] to rank banks by their research activity; some banks are among the world's most advanced. RePEc is regarded as the biggest economic research repository, and its initial purpose was to reduce the time it takes to publish economic research, making the kinds of documents that are traditionally shared at conferences and in working document series more accessible. In other words, the initiative was designed to try and boost the efficiency of informal channels for disseminating research. RePEc now has a coverage of about 3.5 million research items from 3,600 journals and 5,300 working paper series.

2 https://cebra.org/
3 http://repec.org
4 https://ideas.repec.org/top/top.central.html#inst10s

Evaluation of the research activity of central banks and other financial institutions has taken the shape of a wide-ranging set of external evaluation exercises that have developed over the last few years: evaluations by the European Central Bank (Freedman et al., 2011), the International Monetary Fund (2011), the Bank of International Settlements (Allen et al, 2016) and the Bank of England (2019). These evaluations, which are designed to be run regularly, assess qualitative, organizational and quantitative issues – the latter through bibliometric analysis of scientific activity, resulting in reports containing recommendations for organizing and improving research activities. As a result of all these developments, research is now a part of central banks' strategic plans. Some central banks, like the Bank of Spain,[5] are even allowing their research priorities to be posted online.

To the set of factors affecting central banks' research we must add possible fallout from the latest global financial crisis, in that the crisis may have affected central banks' role in most countries. In this sense, the financial crisis has had two kinds of effects. The first is an effect on most central banks' responsibility to ensure the country's financial stability, control the work involved in regulating and supervising the banking sector and define monetary policy objectives (Albulescu, 2011). The second, which enters fully within the objectives of this paper, has been felt in the research central banks have themselves done in response to the crisis, and it has made for a change in researchers' publishing habits, not only in the continuous publication of papers in scientific journals, but also in research topics and alliances with other agents, be they similar financial institutions in other countries or academic institutions. For Malovaná et al. (2020, p. 2), economic and financial research plays a pivotal role in central banks around the world. Research units are tasked with providing policymakers with inputs which help to expand the knowledge base needed for the central bank's core activities. Given the fact that central banking tasks continue to grow in complexity, the importance of research and the demands placed on it are expected to grow too. In terms of crisis, as pointed out by Kozarić & Fabris (2012), the primary objective of a central bank is to act preventively, in order to avoid it. If this happens, the second objective is to increase the system's resilience to shocks, while the last is crisis management. While the objectives of central banks are different, policies have generally aimed to support the macroeconomy level and address short-term financial stability risks (IMF, 2013).

Similarly, Snowdon and Vane (2005, p. 9) point out, "The lessons from the history of economic thought teach us that one of the main driving forces behind the evolution of new ideas is the march of events."

5 https://www.bde.es/f/webbde/INF/MenuVertical/AnalisisEconomico/AnalisisEconomico/PRIORITIES.pdf

2. The Center for Latin American Monetary Studies (CEMLA)

CEMLA was founded in 1952. At its founding the central banks of Colombia, Cuba, Chile, Ecuador, Guatemala, Honduras and Mexico joined as a*ssociates*, and the Economic Commission for Latin America and the Caribbean (ECLAC) joined as a *collaborating member* (Actividades del Centro de Estudios Monetarios Latinoamericanos, 1954).

From the start CEMLA membership has come in two categories, *associates,* which are central banks or comparable institutions of Latin America and the Caribbean, and *collaborating members,* which are non-Latin-American central banks (of the United States, Canada, Spain, France, the United Kingdom, etc.) and international financial institutions. Collaborating members have the right to speak, but they cannot vote, and they help fund the network. CEMLA is now made up of 51 institutions, 31 of which are central banks with associate status. When the idea of creating CEMLA was first raised, the organizers saw a clear need to secure technical and financial sponsorship from a series of public and private financial institutions and from collaborating central banks that could contribute financial resources and provide technical and scientific staff for training purposes.

CEMLA's statutes were amended in May 2021, making it no longer mandatory for associates to belong to the region of Latin America and the Caribbean. Due to this change, Spain has switched from a collaborating member to an associate. Technical cooperation activities among central banks are frequent, especially between long-standing, prestigious central banks – generally Western banks (the Federal Reserve Board, the European Central Bank, the Bank of Canada, the Deutsche Bundesbank) or international financial institutions (the Bank of International Settlements, the International Monetary Fund) – and central banks only recently created or in developing countries or countries in the process of structural transformation, as in the case of Latin-American countries, whose financial system underwent some major shake-ups starting in the 1990s.

Technical cooperation, defined as "transferring knowledge, exchanging viewpoint and information, standardizing concepts, filling information gaps, creating communication networks and training human resources, among others" (Guzmán-Calafell, 2013, p. 7), takes place mainly at the expert and executive level. It can be arranged through bilateral agreements or organizations like CEMLA. The ultimate purpose of technical cooperation among central banks and monetary authorities, i.e., the achievement of monetary and financial stability, is stated quite explicitly in "International Central Bank Cooperation: ESCB Best Practices" (European Central Bank, 2017, p. 2):

The mission of the ESCB's central bank cooperation activities – both individually and jointly – is to strengthen its relations with non-EU central banks and to foster sound central banking and supervisory practices, thereby contributing to monetary and financial stability.

Research has formed part of CEMLA's objectives from the start, because its organizers perceived the need to develop and elaborate on original economic thought produced in the region. Another trait established early on is a tendency for CEMLA research to be linked to the institution's other activities, like teaching and training, international meetings and its publication programme. In 2000, however, research work was affected by the top-to-bottom reorganization of CEMLA due to budgetary problems.

CEMLA's research functions are now performed through a number of channels: the Central Bank Researchers Network of the Americas (https://www.cemla.org/researchers-network.html), whose technical secretariat is held by CEMLA; the Joint Research Program (https://www.cemla.org/jointresearch.html) and the Central Bank Award Rodrigo Gómez (https://www.cemla.org/centralbankaward.html). Furthermore, there are cooperation agreements with a number of academic institutions and financial institutions, an internship programme (https://www.cemla.org/internship.html) and CEMLA's publication programme (https://www.cemla.org/publications.html).

The initial consideration in this paper is that the aforementioned effects of the economic and financial crisis have impacted the different types of central banks differently. Two distinct populations are considered, using the CEMLA classification that distinguishes between associates (central banks and monetary authorities of Latin America) and collaborating members (central banks from outside the region and other financial institutions). Because this paper covers the period from 2000 to 2019, before Spain changed categories, Spain is in the group of collaborating members, since that was the status the Bank of Spain held during the period in question.

This paper takes a bibliometric study approach. It analyses the documents published by central banks and collaborating members with a view to characterizing the behaviour of their publishing habits, based on the definition and analysis of indicators. This focus has been used widely in the past to analyse central bank research (Jondeau and Pagès, 2003; St-Amant et al., 2005; Sarmiento, 2010; Rybacki and Serwa, 2021), changes in publications in connection with economic events (Eijffinger, 2003; Chang and Ho, 2010; Ugarte et al., 2017; Hsu and Chiang, 2020) and the scientific activity of some economic institutions, like the IMF (Kannappanavar and Vijayakumar, 2001; Aizenman et al., 2011; Cohuarde et al, 2021) and the European Central Bank (ECB) (Gaspar and Vega, 2002; Goodfriend et al, 2004).

Some studies have investigated scientific collaboration (Essers et al., 2020), and numerous bibliometric analyses reflect Latin-American researchers' interest in international collaboration, evaluating its positive effects on increased output and visibility, although a study of collaboration in the area of economics and business administration between 1996 and 2007 reports very low numbers for papers written as collaborations between Latin-American countries (Cardoza and Fornēs, 2011). The importance of collaboration is obvious due to its predictive value, along with other variables, such as the h index of central banks' publications (Rybacki and Serwa, 2021). However, no

other study has yet tackled a large-scale analysis of all the banks in CEMLA using several databases and analysing publication topics. This paper is intended to close this research gap.

3. Objectives and research questions

The objective of this study is twofold: a) to analyse the contribution of the associates and collaborating members of the CEMLA network to academic research output in the without economic crisis and with crisis period and b) to analyse the evolution of research topics throughout the crisis and with crisis periods. To analyse the two groups of banks (associates and collaborating members) in greater detail, two periods are created for all indicators. The first, "without economic crisis", is the period before the 2008 economic crisis; it includes the years from 2000 to 2007. The second period, "with crisis", spans the years from 2008 to 2019. It is in the latter period when the financial crisis began, and it is still affecting the world economy.

It is also the objective of this study to determine if the research topics pursued by CEMLA central banks differ from those pursued by associates and collaborating members before and after the economic crisis.

This bibliometric analysis was guided by three research questions:

- RQ1: How has bank research developed over time? This question seeks to understand the output of authors affiliated with banks and how it has evolved over time, considering the factor of CEMLA classification (associates and collaborating members, with nine banks in each category).
- RQ2: What is collaboration between banks like? Institutional collaboration is analysed to understand the relations between organizations in the two periods.
- RQ3: Are there differences in publication patterns (e.g., topics) before and after the crisis? We analyse the main research topics addressed in banks' output and whether publication topics change after the economic crisis.

4. Data sources and methods

4.1. Data collection and search strategy

Three sources of information were used in this study: Clarivate Analytics' Web of Science (WoS), Scopus (Elsevier) and the EconLit database. The search strategy was designed to collect all the information signed by authors affiliated with central banks in the 2000-2019 period (see Table A.1). Data were downloaded on 23 June 2020 from the Web of Science, 5 July 2020 from Scopus and 20 July from EconLit. WoS and Scopus are multidisciplinary databases, but they were complemented by EconLit, which provides thematic classification according to the journal *Journal of Economic Literature* (JEL).[6]

6 https://www.aeaweb.org/econlit/jelCodes.php?view=jel

The JEL classification consists of 19 main categories further subdivided into subcategories widely used in publications on economics and related subjects. Working papers from EconLit were not considered, in order to avoid duplicates, because many working papers were further published as articles under the same name.

Data from EconLit were harmonized using JabRef software, and the bibliographic management tool Refworks was used to collect basic information on the documents (year, title, source, affiliations) and their subject codes under the JEL classification system. Duplicates were removed. Table 1 and Table 2 summarize the number of documents in the databases. Affiliation information was collected from all three sources.

All associates with at least 10 publications indexed in the Web of Science were selected. All collaborating members were selected except the European Central Bank. The reason for not including the ECB was that its lack of a host country might distort the country-level analysis. Also, due to CEMLA's 2021 statute change, Spain has changed from a collaborating member to an associate in the last year. However, the publications collected for this study only run up to 2019, at which point Spain was part of the collaborating members group.

Table 1. Summary of publications by associates (% in brackets)

Classification	Central Bank	EconLit	Scopus	WoS	Unique documents*
Associates	Argentina	98	12	13	110
		(89.09)	(10.91)	(11.82)	
	Barbados	47	57	34	80
		(58.75)	(71.25)	(42.5)	
	Brazil	673	128	136	907
		(74.20)	(14.11)	(14.99)	
	Chile	537	278	117	684
		(78.51)	(40.64)	(17.11)	
	Colombia	330	311	173	571
		(57.79)	(54.47)	(30.30)	
	Mexico	322	181	193	447
		(72.04)	(40.49)	(43.18)	
	Peru	51	22	18	60
		(85.00)	(36.67)	(30.00)	
	Uruguay	45	13	22	57
		(78.95)	(22.81)	(38.60)	
	Venezuela	27	14	10	38
		(71.05)	(36.84)	(26.32)	

Table 2. Summary of publications by collaborating members (% in brackets)

Classification	Central Bank	EconLit	Scopus	WoS	Unique documents*
Collaborating members	Germany	701	651	536	1,452
		(48.28)	(44.83)	(36.91)	
	Canada	673	445	526	854
		(78.81)	(52.11)	(61.59)	
	Spain	510	439	376	833
		(61.22)	(52.70)	(45.14)	
	France	867	520	487	1,170
		(74.10)	(44.44)	(41.62)	
	Hungary	109	53	35	153
		(71.24)	(34.64)	(22.88)	
	Italy	1495	713	792	1,786
		(83.71)	(39.92)	(44.34)	
	Portugal	59	268	268	348
		(16.95)	(77.01)	(77.01)	
	Switzerland	381	290	233	433
		(87.99)	(66.97)	(53.81)	
	USA	7,655	5,399	5,924	10,061
		(76.09)	(53.66)	(58.88)	

Note: Unique documents are calculated considering all three databases.

4.2. Development of bibliometric indicators

The following indicators were analysed for the final dataset.

1) Research patterns

- Yearly trend of scientific output. That is, papers and other document types (e.g., reviews) at least one of whose authors is affiliated with a national bank. Growth is analysed using the cumulative average growth rate (United Nations-ESCAP, 2015). To determine if the growth in the scientific production of both groups throughout the period analyzed showed statistically significant differences, a dummy variable was used in a regression analysis, adding 0 to the period without crisis (2000-2007) and 1 to the period with crisis (2008-2019). Data processing has been carried out with tools for statistical processing, using the functions for adjusting linear regression models, included in the basic statistical package of R Core Team (2023).

- Overlap between databases. In this study documents from three databases (EconLit, Scopus and Web of Science) were compiled and the overlap between sources was checked.

2) Identified interrelations between banks.

- Institutional collaboration. A co-authorship network was created using the VOSviewer tool. Each node indicates a central bank, and node size is related to the number of documents. Co-occurrence links identify co-joint relationships, whereas link thickness shows the intensity.[7]

3) Identified topics

- Temporal evolution of topics by banks. In order to test the underlying relationships between the topics on which banks in the different countries published during the study period, multiple correspondence analysis (MCA) was used to reduce the size of the contingency table among the categories of the variables to be analysed (Greenacre and Blasius 2006). The data matrix was constructed from the variables year of publication, subject code (JEL)[8] and country of the bank-affiliated author. In this analysis the principal variables were publication year and subject code (JEL), whereas country was the complementary variable.

Multiple correspondence analysis (MCA) is an exploratory data analysis which examines the interdependence among a set of multiple categorical variables and detects underlying structures on a multidimensional plane. This technique is a common tool used in advanced bibliometrics to explore and visualize information to map scientific development as well as interactions among bibliometric data while also providing quantitative data on the structure of the relationships between the system elements to which they are applied (Callon, Courtial, & Penan, 1995). It should be highlighted, however, that this technique has exploratory value in that it describes data and shows proximity between a group of elements (interrelations) without investigating the causes of the structures discovered (Greenacre & Blasius, 1994).

In this case the input was a three-dimensional matrix with three categorical variables: country, publication year and JEL topic. MCA was performed using the R statistical software (version 4.0.2) (R Core Team, 2023) and the FactoMineR package (version 2.4). The first two dimensions were represented, because in both analyses these dimensions by themselves explain more than 45% of the variability of the data distribution.

5. Results and discussion

5.1. Research patterns

A total of 19,973 unique documents from the target period were obtained. Of these, 16,959 documents (84.91%) are by collaborating members, and 2,954 (14.79%) are by associates. Figure 1 shows the evolution of documents

7 https://www.vosviewer.com/

8 The JEL classification system was developed for use in the *Journal of Economic Literature* (JEL) and is a standard method of classifying scholarly literature in the field of economics. The system is used to classify articles, dissertations, books, book reviews and working papers in EconLit and in many other applications. https://www.aeaweb.org/econlit/jelCodes.php

published during the two periods we have divided the scientific production (without economic crisis and with crisis). Related to this figure, Table 3 shows the results of the regression analysis for the two institutional groups (associates and collaborating) where it can be seen that the dummy variable included in the regression is statistically significant in both groups, which reinforces our results in the sense that the trend in the growth of scientific production has been significantly affected by the crisis. In terms of cumulative growth rates, which analyze fluctuations over time, while the associates' growth rate was 6.76%, the collaborating member's growth the 3.35% during the period (without and with crisis). In absolute terms, the total number of documents published by both associates and collaborating members was much higher during the crisis period: 76% of associates' documents (2,246) and 70% of collaborating members' documents (11,871) were published in this period.

Many other researchers investigating central banks' scientific activity have also observed big growth in banks' scientific output. Malovaná et al. (2020) find that in a time span similar to our target period (2000-2018) the number of publications by 55 European and U.S. central banks grew by 40%. Earlier work yields similar results. For example, the study by Claveau and Dion (2018) analyses the evolution of publications by central bank researchers in three of the most prestigious journals in the field of monetary economics (*Journal of Monetary Economics, Journal of Money, Credit and Banking* and *International Journal of Central Banking*). The results show a

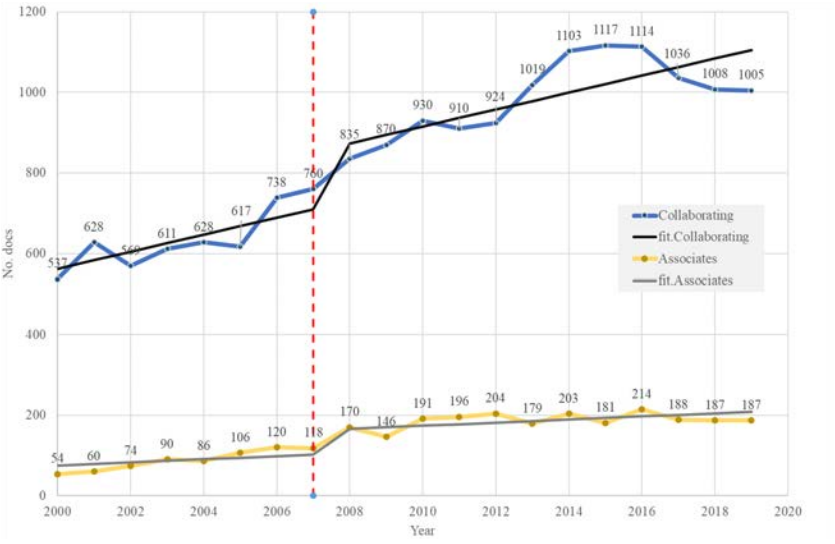


Figure 1. Yearly evolution of the scientific output of associates and collaborating members. Duplicates were removed.

clear positive trend in the number of central bank publications, especially in the last year of the period Claveau and Dion investigated (1976-2015), when the number of publications rose by 50%, in contrast to the 15% growth they observed in the previous period (1976-1980). For the authors of that study, the results prove a growing tendency on the part of central banks to be ever more present in specialized scientific journals. Claveau and Dion's result, although high, is considerably lower than the growth rate found in the present paper for the entire period analysed (87.15% for collaborating members and 246% for associates).

Other authors, like Windsor (2021), have also observed that research on the banking sector has significantly increased since the 2000s, especially since the economic crisis. Pattnaik et al. (2020) also found in a bibliometric analysis on scientific production in banking and finance, production and operations that the number of publications on this subject after 2008 increased by 69% compared to the years prior to the financial crisis. The uptick in publications since the global economic crisis is also observed in our work, since the scientific output of both collaborating members and CEMLA associates increased considerably during the crisis period. Publications since the crisis account for 70% of all publications by collaborating members, while the percentage is somewhat higher (76%) for associates.

Table 3. Comparison of models: regression statistics

	Dependent variable:	
	Collaborating	Associates
	(1)	(2)
Year	21.105***	3.838***
	(4.343)	(1.274)
Crisis (*dummy*)	142.196**	60.288***
	(51.124)	(14.999)
Constant	-41,648.680***	-7,600.608***
	(8,702.128)	(2,553.023)
Observations	20	20
R^2	0.920	0.906
Adjusted R^2	0.910	0.895
Residual Std. Error (df = 17)	59.077	17.332
F Statistic (df = 2; 17)	97.615*** (p = 0.000)	82.313*** (p = 0.000)

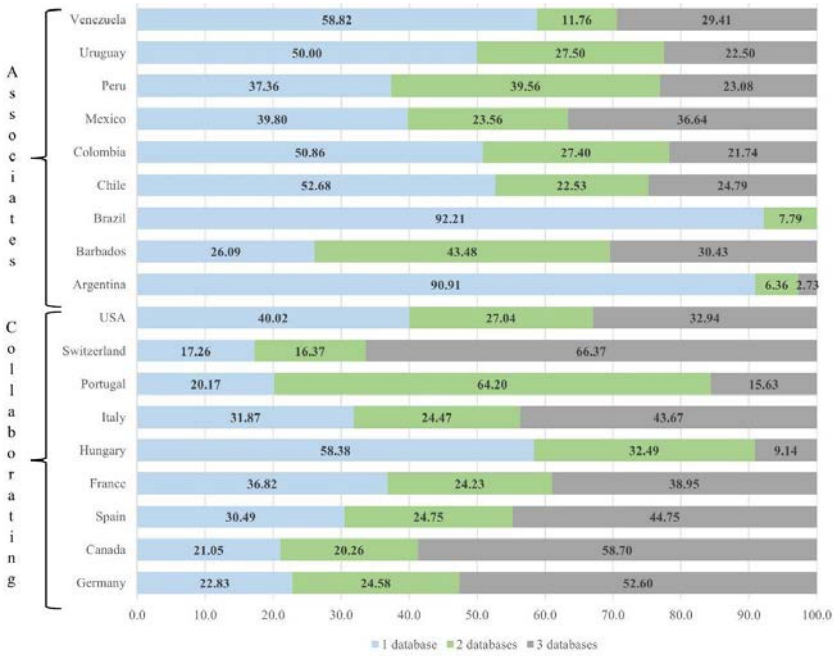
Note: *p<0.1; **p<0.05; ***p<0.01

Recent analyses in the economics area have also revealed major growth in terms of the number of academic publications both in European countries (Combes and Linnemer, 2003; Tombazos, 2005; Duque, Ramos and Royuela 2011; Glötzl and Aigner, 2017) and in Latin-American countries (Cardoza and Fornés, 2011; Bonilla et al, 2015; Coronado et al, 2021). When analysing the research output of central banks published in scientific journals, we must make allowance for certain special features that differentiate banks from academic institutions. Malovaná (2020, pp.6-7) puts it thus:

One cannot simply apply academic criteria to central bank research publications. Many central banks use their own publication series to exchange ideas about bank-specific topics with other central banks and regulatory institutions, academia or the wider economic community. Central banks' paper series might be technical and also theoretical in nature, but, in essence, they form an easily accessible knowledge base. In this regard, research publications help to increase central banks' transparency.

Last, to understand the output and the scientization, the size of the Central Banks should be considered. The average size of the associates is 1,998

Figure 2. Percentage of overlap between sources by countries



1 database is the percentage of papers located in one source only; 2 databases is the percentage of papers appearing in two sources; 3 databases is the percentage of papers appearing in three sources.

employees whereas for the collaborating members is 6,438 (Table A.2.). According to Trichet (2002), central banks need first-rate in-house research on monetary and financial economics for policy implementation and for other central bank functions and tasks.

Figure 2 shows the overlap between data sources (EconLit, Web of Science and Scopus) to determine document coverage. The collaborating countries (e.g., Germany, Canada, Switzerland) have good document coverage; more than 40% of their documents are in all three databases (with the exception of Hungary with 9% and Portugal with 15%). This is not surprising, as these countries lead the worldwide scientific output (Mongeon and Paul-Haul, 2015). The associates have a lower coverage rate (the highest is Mexico with 36.6%), even including one country (Brazil) with coverage in in two databases.

5.2. Identified institutional collaboration

Institutional network analyses were conducted to identify patterns of collaboration in both groups of banks and to check whether there were changes between publication before the crisis or after. In general, the associates had fewer collaborations with other institutions in the crisis period while collaborating banks show the opposite behaviour, since it is precisely in the crisis period when they show greater research activity in collaboration with other institutions.

5.2.1. Associates

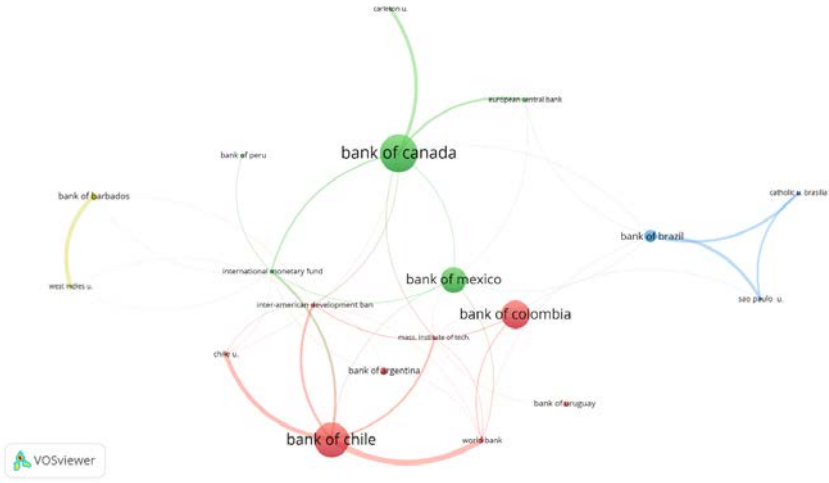
a) Without crisis (2000-2007) (number of papers: 708)

Figure 3 shows the network of institutional collaboration in the without crisis period. There are four clusters. Node size indicates the number of documents, while intensity of relations (line thickness) indicates co-occurrence (that is, the number of documents produced in collaboration) between two institutions. The first cluster (green, at the top of the map) has the Bank of Canada (with 652 documents) as the main node. The Bank of Canada works in close collaboration with Carleton University (15 documents), the European Central Bank (10 documents) and, to a lesser extent, the IMF (7 documents) and the Bank of Mexico (3 documents). The second cluster (red, at the bottom of the map) has two main nodes, the Bank of Chile (588 documents) and the Bank of the Republic of Colombia (444 documents). The Bank of Chile has strong collaborative ties to the World Bank (25 documents), the University of Chile (19 documents) and the Inter-American Development Bank (11 documents). The Bank of the Republic of Colombia engages in less-intensive collaboration; its main collaborating partners are the World Bank (4 documents) and the Inter-American Development Bank (4 documents). The third cluster (blue, at the left side of the map) is made up of the Bank of Brazil (148 documents) and two Brazilian universities with which it collaborates (University of São Paulo, 14 documents; Catholic University of Brasilia, 12 documents). Lastly, the fourth

and smallest cluster (yellow, at the top right) contains the Bank of Barbados in collaboration with the University of the West Indies (18 documents).

The results underscore a lack of collaboration in scientific output between the CEMLA associates and most of the collaborating banks, with the exception of the Bank of Canada (some associates, like the Bank of Mexico, do collaborate with the Bank of Canada). The rest of the collaborating banks have no scientific collaboration with associates. Another interesting finding of this analysis is that the central banks of Chile and Colombia are engaged in busy research activity, in terms of both publications and collaboration. These two banks' lively activity has already been described by Ochoa and Schmidt-Hebbel (2006) and documented by Sarmiento (2010) based on the publication of working papers; Sarmiento stresses the strong collaboration of the central banks of Chile and Colombia with other central banks in Latin America and the more developed economies.

Figure 3. Collaboration by associates in the without crisis period



b) Crisis (2008-2019) (number of papers: 2,246)

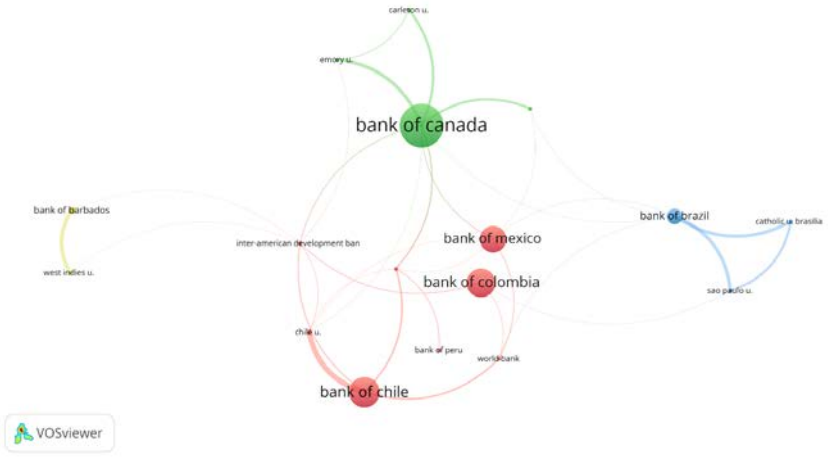
In the crisis period 2,246 documents were published, three times more than in the without crisis period. Even so, the number of clusters and the relations among banks remains the same as in Figure 4. In the first cluster (green, at the top of the map) the main bank is the Bank of Canada (449 documents), which still collaborates with the Central European Bank (9 documents), Carleton University (10 documents) and the Bank of Mexico (3 documents); the Bank of Mexico is a nexus linking the green cluster to the second cluster (red, at the bottom of the map). In addition to the Bank of Mexico (255 documents), the red cluster includes the central banks of Colombia (285 documents) and

Chile (305 documents), which are the central banks with the largest number of publications in this period. These two banks also collaborate with the Inter-American Development Bank. The Central Bank of Chile still collaborates steadily with the University of Chile (20 documents) and the World Bank. However, the number of collaborations with the World Bank is considerably higher in this second period, rising from 25 joint publications in the first period to 36 in the second.

The cluster led by the Bank of Brazil (122 documents) (blue, at the right of the map) shows that the Bank of Brazil still collaborates the most with the Catholic University of Brasilia (12 documents) and the University of São Paulo (13 documents), and it remains isolated from the rest of the region's central banks.

The fourth cluster (yellow, at the left side of the map) is led by the Bank of Barbados (41 documents), which continues to collaborate with the University of the West Indies (14 documents).

Figure 4. Associate co-authorship (minimum > 10 documents)



5.2.2. Collaborating members

a) Without crisis (2000-2007) (number of publications: 5,088)

Figure 5 is the map of institutional collaboration by collaborating members. There are four clusters in this network. At the left of the map, in red, is the cluster led by the U.S. Federal Reserve, whose output (3,994 documents) is far higher than that of the other banks. In this study all the subdivisions of the Federal Reserve are unified into a single institution to facilitate representation. The Federal Reserve has strong collaborative ties with a range of North-American institutions (University of Minnesota, 71 documents; National Bureau

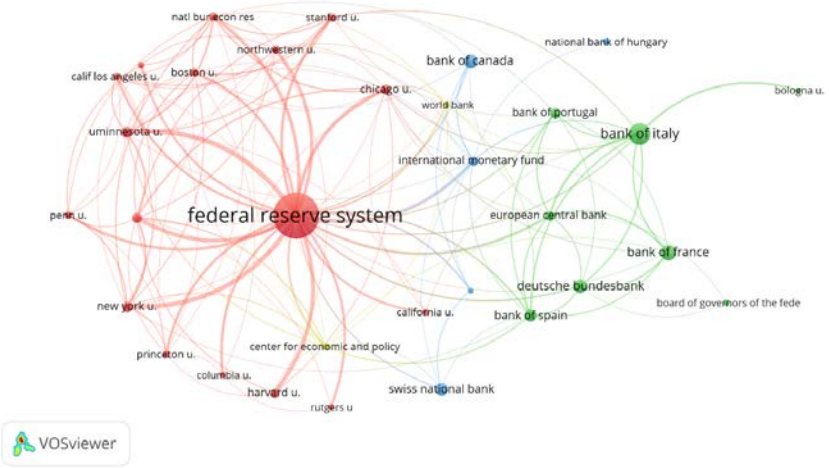
of Economic Research, 50 documents; Harvard University, 48 documents). The second cluster (green, at the right side of the map) contains banks like the Bank of Italy (499 documents), the Deutsche Bundesbank (140 documents) and the Bank of Spain (109 documents). The third cluster (blue, in the centre of the map) covers the Bank of Canada (158 documents), the Swiss National Bank (114 documents) and the Bank of Hungary (28 documents), among others. The last cluster (yellow) is made up of the World Bank (17 documents) and the Center for Economic and Policy Research (CEPR) (25 documents). The yellow cluster has a lower output, and the collaboration among its component institutions is much less intense.

The central position of the Federal Reserve may be explained by the institution's having many component subdivisions, but it may also be due to specialization, as Goodfriend (1999, pp. 7-8) asserts:

Reserve Bank research departments often develop a specialization. A Reserve Bank president may encourage research of one type or another; or a particularly skillful economist may happen to make a department strong in a particular sort of research. A Bank may also exploit a feature of its regional economy or its operational responsibilities to develop a research advantage.

Another important aspect of the Federal Reserve System is its strong sientific collaboration with numerous highly prestigious academic institutions, such as Boston University, Stanford and Harvard.

Figure 5. Institutional collaboration by collaborating members in the without crisis period (minimum > 15 documents)



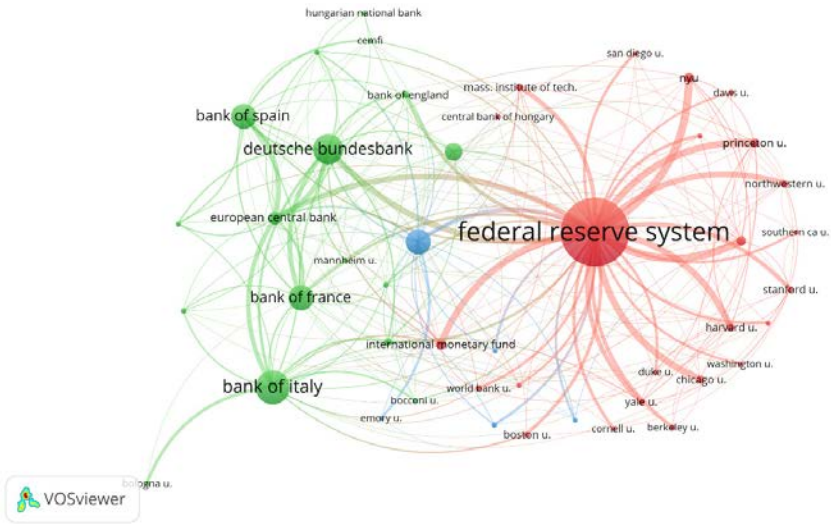
b) Crisis (2008-2019) (number of publications: 11,871)

In the second period, with 2.3 times more publications than the first, the number of clusters remains the same, although there is a considerable

increase in inter-bank collaboration. For example, the cluster led by the Federal Reserve System, which remains the most productive institution (4,091 documents), collaborates more intensely with international organizations like the International Monetary Fund (45 publications), the Deutsche Bundesbank (39 documents) and the European Central Bank (35 documents). In the cluster containing the central European banks of Germany (724 documents), Italy (940 documents), France (493 documents) and Spain (495 documents) (green, at the left side of the map), the number of publications rises sharply as well, as shown by link thickness, which is considerably greater than in the first period.

The high number of publications by the Federal Reserve System throughout the study and its researchers' numerous collaborations with other institutions' researchers echoes the figures found in other papers. In a study of the publications of 50 central banks from 2000 to 2019, Malovaná et al. (2020, p. 11) find that "The US Federal Reserve Banks and the FRB show a relatively high share of authors with multiple affiliations, which translates to stronger collaboration networks with positive synergies for the quantity and quality of research outcomes." The scientific output of the Federal Reserve System accounts for 37.25% of all publications of the 55 central banks. The Federal Reserve System's contribution in the case analysed here is larger, since it nears 60% of the total (58.87%). The higher percentage found here may be due to the smaller number of central banks considered (9) and the exclusion of working papers.

Figure 6. Institutional collaboration by collaborating members in the crisis period (minimum > 15 documents)



5.3. Identified research topics

This section reports the results of the analysis of the topics that associates and collaborating central banks preferred to address during the period covered by this study (2000-2019). Multiple correspondence analysis was used to find the relationships among the variables of document topic (according to the JEL classification), publication date and signing institution. Overall, the topics changed from monetary policy issues and macroeconomic topics in general before the crisis (linked to the usual main mandate of central banks of maintaining the price stability) while the macro-finance topics refers to macroprudential policy frameworks developed in order to analyze systemic risks and promote financial stability. For both analyses a threshold of at least 50 published documents was set to facilitate the visualization of the resulting maps.

5.3.1. Associates' research topics

The graph of the MCA results (Figure 7) shows the distribution of the variables in the space made by axis 1 (publication year) with an inertia of 38.8% and axis 2 (JEL topic) with an inertia of 10.87%. The axes dividing the map show two clearly defined periods corresponding to the years before the financial crisis (left-hand quadrants) and the years from the time the crisis broke out in 2008 until 2019 (right-hand quadrants). Topics concerning the category of Economic Development, Innovation, Technological Change and Growth (O) (for example, Economic Development (O1) and Development Planning and Policy (O2)) are also concentrated together. The next category is E, Macroeconomics and Monetary Economics. This category is reflected in one of the functions CEMLA has performed since its foundation. The next category on the graph is International Economics (F), more specifically International Finance (F3). In the left-quadrant the Central Bank of Chile is linked to these topics and publication dates, thus showing it has a specialized profile.

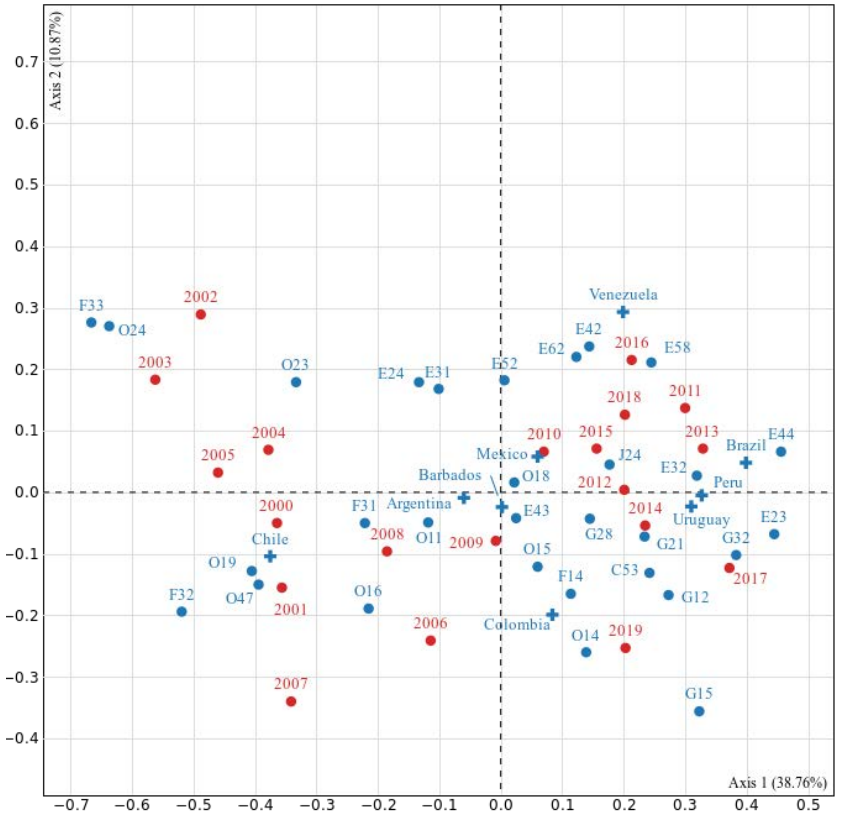
To the right of the map appear the more recent publications. They are all post-2008 and therefore lie within the crisis period. New research topics crop up in this period, and the variety of JEL topics is greater, including G (Financial Economics) and J (Labour and Demographic Economics).

The Central Bank of Venezuela has a more specialized profile and publishes primarily on Macroeconomics and Monetary Economics: General (E), especially Monetary Policy, Central Banking and the Supply of Money and Credit (E5), Money and Interest Rates (E4) and Macroeconomic Policy, Macroeconomic Aspects of Public Finance and General Outlook (E5). The central banks of Peru, Brazil and Uruguay (which lie near one another on the map due to their proximity in terms of publication dates and topics) are specialized in topics from category E, such as E3 (Prices, Business Fluctuations and Cycles) and E4. The Bank of Colombia also displays a profile different from that of the other

associates; it is linked in terms of time to the last year analysed (2019) and in terms of topics to Trade (F1), particularly Empirical Studies of Trade (F14).

Part of the research observed in the second period (2009-2019) consolidates the results obtained in the first period, inasmuch as a large share of the publications has to do with Macroeconomics and Monetary Economics: General (E). However, another major portion of the research falls into the category of Financial Economics (G): General. As has already been mentioned, these are the two categories where 30 central banks have the highest publication percentages from 2000 to 2007, as ranked by the Bank for International Settlements (BIS) (Sarmiento 2010). These changes in research may have been partly caused by the decision by the central banks in CEMLA to aim their research efforts at monetary policy and financial stability (Ortíz, 2018).

Figure 7. MCA (country, publication year, topic) of associates (with >50 documents)



In the centre of the map lie the publications whose profile is less differentiated, that is, topics on which a large number of the associates publish. The banks of Argentina, Mexico and Barbados publish fundamentally in the category of Macroeconomics and Monetary Economics: General (E). This fact may be, as Rybacki and Serwa (2021, p. 6) claim, because "studies on monetary policy and inflation (JEL code E) have greater priority in comparison to other research categories", and because they are also the studies with the highest impact.

As mentioned before, associates' research topics display various differences. In the first (2000-2008) research period, the associates' research partly coincides with the research done by the 30 central banks of the majority of the countries ranked by the BIS with respect to working papers published in the 2000-2007 period (Sarmiento 2010), since quite a few of them (including Brazil, Colombia and Barbados) published on topics related with Macroeconomics and Monetary Economics: General (E). In the BIS ranking, 32.7% of the publications are linked with this category, followed by 18.1% linked with Financial Economics (G) and, in third place (13%), publications related with Mathematical and Quantitative Methods (C). Our research did not find publications by associates in the first period in these two latter categories. However, associates did publish in the categories of Economic Development, Innovation, Technological Change and Growth (O) and in International Economics (F). The Central Bank of Chile is the specialist in this latter category; this finding chimes with the BIS ranking (Sarmiento 2010).

5.3.2. Collaborating member research topics

The same procedure as followed with the associates was applied to the collaborating members to ascertain their research topics. The resulting map (Figure 8) shows an inertia of 12.05% for the first dimension and 35.17% for the second. Like Figure 7, this map groups the without crisis years together and the crisis years together. However, their positions are inverted, with the older, without crisis period in the right-hand quadrants and the crisis years in the left-hand quadrants. Overall, the position of the variables shows a strong relationship between JEL categories and countries, as indicated by the fact that they lie very close to each other on the map.

In the bottom right-hand part (the without crisis years) we find E (Macroeconomics and Monetary Economics), O (Economic Development, Innovation, Technological Change and Growth) and D (Microeconomics). In terms of countries, only Switzerland and the USA published on topics related to E52 (Monetary Policy) and E31 (Price Level; Inflation; Deflation) in the first period and E23 (Macroeconomics: Production) and E22 (Investment; Capital; Intangible Capital; Capacity) in the second period. As can be seen on the map, in the without crisis period the publications by the Central Bank of Portugal clearly specialized in topics related with Economic Development, Innovation, Technological Change and Growth (O), while at the outbreak of the crisis (2009)

the central banks of Italy and Switzerland published fundamentally on topics related with Macroeconomics and Monetary Economics: General (E).

In the bottom left quadrant (2010-2012), the publication topics are specialized in categories F (International Economics), G (Financial Economics) and H (Public Economics).

Spain proves to be a special case, because it stands alone and closely linked to G01 (Financial Crises). Another interesting feature of this quadrant is the presence of topics G28 (Government Policy and Regulation), G15 (International Financial Markets) and G12 (Asset Pricing, Trading Volume, Bond Interest Rates). Most of the collaborating members publish on these topics, which explains their central positions on the map.

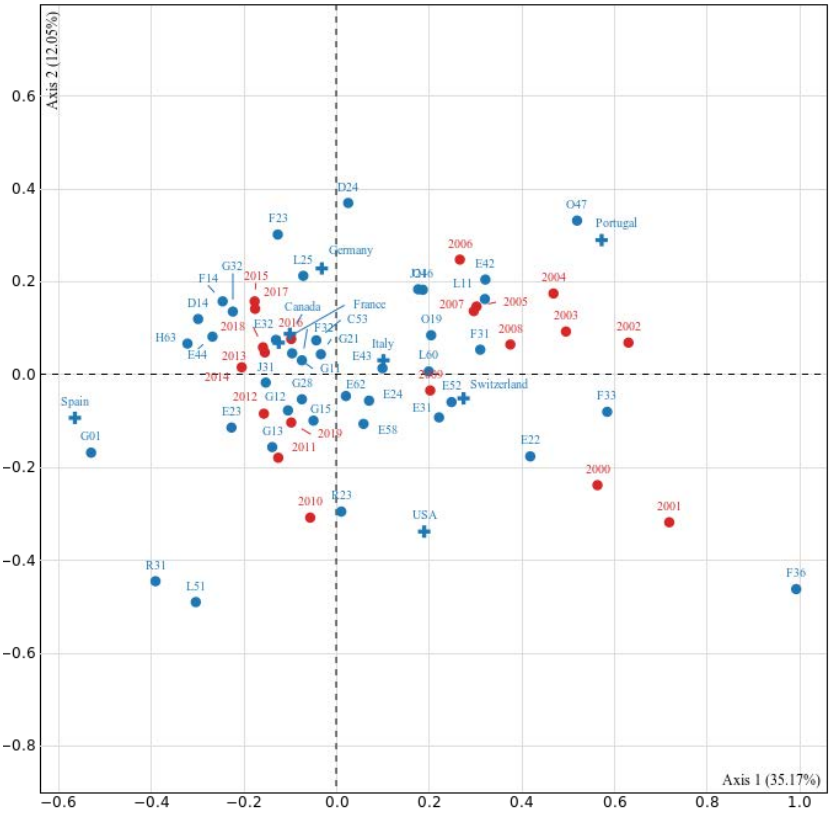
Finally, in the top left quadrant, France, Canada and Germany form a cluster (2013-2017) addressing a large number of JEL categories (e.g., G32 Financing Policy; Financial Risk and Risk Management; Capital and Ownership Structure; Value of Firms; Goodwill; E32 Business Fluctuations; Cycles and L25 Firm Performance: Size, Diversification, and Scope). Also in this quadrant are categories G11 (Portfolio Choice and Investment Decisions), G21 (Banks, Depository Institutions, Micro Finance Institutions and Mortgages) and F32 (Current Account Adjustment and Short-Term Capital Movements), which occupy a central position on the map. The majority of the collaborating members publish on these centrally placed topics. Comparison shows that these results on the collaborating members' research specialization closely resemble the results found in other studies on European and North-American banks. For example, in the study by Malovaná et al. (2020), the first two categories are Macroeconomics and Monetary Economics (E) and Financial Economics (G). In our study these two categories lie in the central portion of the map (intersection of the coordinate axes), which means that in the 20 years covered by our study most of the central banks we analysed published a large number of papers in these two categories. Malovaná et al. (2020) claim that this reflects the two main objectives of central banks (price stability and financial stability) and the two main sets of instruments usually at their disposal (monetary policy and prudential policy). These two JEL categories are the ones that appear with higher publication percentages in 30 central banks in the BIS ranking (Sarmiento, 2010).

Windsor (2021) found similar results when analysing the subjects of central banks' scientific output on the basis of abstracts downloaded from RePEc's IDEAS database. The highest number of publications was linked with category G2 (Financial Institutions and Services) and category E31 (Price Level, Inflation and Deflation). Windsor also observed that publications related with category D1 (Household Behavior and Family Economics) increased considerably in the crisis period. In our results we also find that the publications related with category D14 (Household Saving), in the upper left-hand area of the map, date from the latter years of the crisis.

The categories of Financial Economics (G) and Macroeconomics and Monetary Economics: General (E) fall in the central portion of the map (centre

of the axes and coordinates). These are the categories in which most of the central banks published the highest number of documents in both periods.

Figure 8. MCA (country, publication year, topic) of collaborating members (with > 50 documents)



6. Conclusions

Central banks are public institutions that play a fundamental role in a country's monetary policy. However, it was not until the mid-20th century that central banks became aware that they required increasing support from economic science to implement their monetary policies and pursue their objectives in general. The realization spurred research activities aimed at favouring an increase in practical and theoretical knowledge, to make decision making more robust. Faced with this new scenario, central banks began to "scientize" their activities, recruiting scientific experts in financial and monetary

areas for their staff. Central banks' important function in countries' monetary policy played a fundamental role in the last global financial crisis, as central banks were called upon to ensure monetary stability.

For these reasons it is of interest to analyse, from a bibliometric approach, the characteristics of the research done by central banks in two groups – the central banks of the Latin-American countries represented by CEMLA and the central banks of some of the collaborating members of CEMLA in the developed countries – during the without crisis period of 2000-2007 and the crisis period of 2008-2020.

The scientific output of the collaborating members and associates is quite different, although in absolute terms the number of publications by the collaborating is much higher; since they are responsible for almost 85% of the publications. However, in terms of accumulated growth rates, the growth rate of associates was higher (6.76%) than that observed for collaborators (3.35%) during the period (without and with crises). It should be noted that the crisis had an important effect on the scientific production of both groups of banks, since statistically significant growth has been observed throughout the entire period analyzed (with and without crises).

The collaborating members' scientific publications have better coverage in the three databases than the associates'. More than 40% of the collaborating members' publications are present in all three databases, while the same can be said for less than 20% of the CEMLA associates. The Central Bank of Switzerland stands out, with close to 67% of its publications present in all three databases, as does the Bank of Brazil at the opposite extreme, with two databases overlapping.

The results of the analysis of the two periods lead to some interesting conclusions about collaboration. First of all, associates collaborate to different degrees. The central banks of Chile and Colombia stand out; the former is noteworthy for the intensity of its collaboration with academic and international institutions. Another conclusion about collaboration is that the Central Bank of Brazil plays quite a minor role: despite Brazil's standing as a South-American powerhouse, its central bank fundamentally collaborates with just two Brazilian academic institutions. Lastly, there is a lack of collaboration in scientific output between associates and the majority of the collaborating members, except for the Bank of Canada. While the Bank of Canada is not an associate, it does collaborate continuously with most of the CEMLA associates and thus plays the role of research driver.

One of the collaborating members, the Federal Reserve System, plays quite a large role in both periods. It is the leading collaborating member by output, and it leads in collaboration with different national and international institutions. Many of its international collaborations are with the central banks of other countries, for instance, the Bank of Italy, the Deutsche Bundesbank and the Bank of Spain. Furthermore, the Federal Reserve System's commitment to specialization may lie behind its extensive network of collaboration with the finest U.S. universities. Another conclusion that may be drawn from the

collaborating members' networks of scientific collaboration is that there is strong collaboration among most of the central banks we analysed, especially in the crisis period. A very different picture is observed in the case of the associates, whose collaboration feeds on clusters made up of a small number of institutions that are practically isolated from each another.

On the subject of research topic evolution, in the first period of the study associates published fundamentally on International Economics (F) and Economic Development, Innovation, Technological Change and Growth (O), while in the second period their specialization veered toward topics more closely linked with Macroeconomics and Monetary Economics (E) and Financial Economics (G). Furthermore, the categories in which the collaborating members published the most in both periods are Macroeconomics and Monetary Economics (E) and Financial Economics (G). The first coincides with the category most favoured by associates, but not the second, since associates also publish a large number of papers on Economic Development, Innovation, Technological Change and Growth (O), which might be related that their mandates cover these subjects like in the case of Brazil.

Furthermore, collaborating members display a greater variety of research topics in the without crisis period. Some topics are similar to those chosen by associates, such as subjects related with Economic Development, Innovation, Technological Change and Growth (O) or International Economics (F), to name but two. In the crisis period the collaborating banks focused their research on Financial Economics (G), International Economics (F) and Macroeconomics and Monetary Economics (E).

One of the limitations of this study is the use of keywords for selecting banks' research, a strategy that might fail to capture the whole output. Another limitation is that restricting the sources to the three databases may under-represent related published works indexed in other scientometric databases (e.g., Google Scholar, Dimensions). Additionally, the three chosen sources (especially WoS and Scopus) do not cover all academic fields equally, as they under-represent non-English studies. Finally, the methodology may not necessarily capture the whole picture of related research, as some other potentially interesting document types (e.g., reports) were not included.

ACKNOWLEDGMENTS

The authors would like to thank the referees for their interesting comments and suggestions, which have been very useful to improve the quality of the manuscript. We also want to thank Professor Carlos García Zorita for his wise statistical advice.

References

Actividades del Centro de Estudios Monetarios Latinoamericanos. (1954). *El Trimestre Económico*, 21 (83-3), pp. 356–363. http://www.jstor.org/stable/20855372

Aizenman, J. Edison, H. Leony, L. & Sun, J. (2011). *Evaluating the Quality of IMF Research: A Citation Study*. (IEO Background Paper BP/11/01). International Monetary Fund. Independent Evaluation Office.

Albulescu, C.T. (2011). Macro-financial Risks & Central Banks: What Changes Has the Crisis Triggered? *Timisoara Journal of Economics*, 4 (3), pp. 135-142.

Allen, F. Bean, C. & De Gregorio, J. (2016). *Independent Review of BIS Research: Final Report*. https://www.bis.org/forum/research/review_research.pdf

Bank of England, IEO (Independent Evaluation Office) (2019). *Evaluation of the Bank of England's Research Report*. https://www.bankofengland.co.uk/-/media/boe/files/independent-evaluation-office/2019/evaluation-of-the-bank-of-englands-research.pdf

Bonilla, C.A. Merigó, J.M. & Torres-Abad, C. (2015). Economics in Latin America: A Bibliometric Analysis. *Scientometrics*, 105(2), pp. 1239-1252. https://doi.org/10.1007/s11192-015-1747-7

Callon, M., Courtial, J. P., & Penan, H. (1995). *Cienciometría: el estudio cuantitativo de la actividad científica*. TREA, Oviedo.

Cardoza, G. & Fornês, G. (2011). International Cooperation of Ibero-American Countries in Business Administration and Economics Research: Presence in High Impact Journals. *European Business Review*, 23(1), pp. 7–22. https://doi.org/10.1108/09555341111097964

Chang, C.C. & Ho, Y.S. (2010). Bibliometric Analysis of Financial Crisis Research. *African Journal of Business Management*, 4(18), pp. 3898-3910.

Claveau, F. & Dion, J. (2018). Quantifying Central Banks' Scientization: Why and How to Do a Quantified Organizational History of Economics. *Journal of Economic Methodology,* 25 (4), pp. 349-366. https://doi.org/10.1080/1350178X.2018.1529216

Combes, P.P. & Linnemer, L. (2003). Where Are the Economists Who Publish? Publication Concentration and Rankings in Europe Based on Cumulative Publications. *Journal of the European Economic Association,* 1(6), pp. 1250-1308. https://doi.org/10.1162/154247603322752548

Coronado, F. Meridó, J. M. & Cancino, C. (2021). Business and Management Research in Latin America: A Country-Level Bibliometric Analysis. *Journal of Intelligent & Fuzzy Systems*, 40 (2), pp. 1865-1878. https://doi.org/10.3233/JIFS-189192

Duque, J. C. Ramos, R. & Royuela, V. (2011). Research Networks and Scientific Production in Economics: The Recent Spanish Experience. *Ecos de Economia: A Latin American Journal of Applied Economics*, 15 (32), pp. 121-132. https://diposit.ub.edu/dspace/bitstream/2445/32805/1/600096.pdf

Eijffinger, S. C. (2003). The Federal Design of a Central Bank in A Monetary Union: The Case of the European System of Central Banks. *International Journal of Finance & Economics*, 8 (4), pp. 365-380. https://doi.org/10.1002/ijfe.214

Eijffinger, S. C. De Haan, J. & Koedjik, K. (2002). Small Is Beautiful: Measuring The Research Input and Output of European Central Banks. *European Journal of Political Economy*, 18 (2), pp. 365-374. https://doi.org/10.1016/S0176-2680(02)00086-1

Essers, D. Grigoli, F. & Pugacheva, E. (2020). Network Effects and Research Collaborations. (IFM Working Paper, 2020/144*)* International Monetary Fund. https://doi.org/10.5089/9781513550879.001

European Central Bank (2017). *International Central Bank Cooperation: ESCB Best Practices*. https://www.ecb.europa.eu/ecb/tasks/international/financialarchitecture/shared/pdf/ecb.central_bank_cooperation_escb_best_practices.en.pdf

Freedman, C. Lane, P. R. Repullo, F. & Schmidt Hebbel, K. (2011). *External Evaluation of the Directorate General Research of the European Central Bank*. https://www.ecb.europa.eu/pub/pdf/other/ecbresearchevaluationfinalen.pdf.

Gaspar, V. & Vega, J. L. (2002). Research at a policy making institution: Launching research at the ECB. *Revue Suisse de Economie et de Statistique*, 138(4), pp. 359-376. http://www.sjes.ch/papers/2002-IV-3.pdf

Glötzl, E. & Aigner, E. (2017) *Six Dimensions of Concentration in Economics: Scientometric Evidence from a Large Scale Data Set.* (Ecological Economic Papers No. 15) Institute for Ecological Economics, Vienna University of Economics and Business. https://epub.wu.ac.at/5488/

Goodfriend, M. (1999) The Role of a Regional Bank in a System of Central Banks. IN *Carnegie-Rochester Conference Series on Public Policy (51),* pp. 51-71. https://doi.org/10.1016/S0167-2231(00)00004-X

Goodfriend, M. König, R. & Repullo, R. (2004). *External Evaluation of the Economic Research Activities of the European Central Bank.* Available at https://www.ecb.europa.eu/pub/pdf/other/ecbresearchevaluationsummaryfinalen.pdf

Greenacre, M. & Blasius, J. (Eds.). (2006). *Multiple Correspondence Analysis and Related Methods*. New York: Chapman and Hall/CRC

Greenacre, M. & Blasius, J. (1994). *Correspondence Analysis in The Social Sciences: Recent Developments and Applications*. London: Academic Press

Guzmán-Calafell, J. (2013) "Opening Remarks." IN Central Bank Cooperation at the Beginning of The 21st Century: CEMLA 60th Anniversary Conference. México D.F.: Centro de Estudios Monetarios Latinoamericanos, pp. 3-8. https://www.cemla.org/PDF/CEMLA_60anniversary.pdf

Hsu, C. L. & Chiang, C. H. (2020). Bibliometric Analysis of Financial Crisis Research. *The Singapore Economic Review*. 1-28. https://doi.org/10.1142/S0217590820500678

International Monetary Fund (IMF) (2013). Do Central Bank Policies Since the Crisis Carry Risks to Financial Stability? Global Financial

Stability Report, April 2013, chapter 3, pp. 93-126. https://doi.org/10.5089/9781475589580.082

International Monetary Fund. IEO (Independent Evaluation Office). (2011) *Research at the IMF: Relevance and Utilization*. Washington, DC: IMF Independent Evaluation Office. Report. https://ieo.imf.org/-/media/IEO/Files/evaluations/completed/06-21-2011-research-at-the-imf-relevance-and-utilization/background-papers.ashx

Jondeau, E. & Pagés, H. (2003). Benchmarking Research in European Central Banks. *Workshop on Central Bank Efficiency, Sveriges Riksbank, Stockholm, May 23-24*. http://archive.riksbank.se/Upload/Dokument_riksbank/Kat_foa/benchmarking%20EJHP.pdf

Kannappanavar, B. U. & Vijayakumar, M. (2001). Authorship Trend and Solo V/S Team Research in International Monetary Fund Literature: A Bibliometric Study. *Annals of Library and Information Studies, 48 (3),* pp.117-120.

Kozarić, K., & Fabris, N. (2012). Monetary Policy at Crisis Times. *Journal of Central Banking Theory and Practice,* 1(1), pp. 5-24. https://cbcg.me/slike_i_fajlovi/fajlovi/journal/vol1/monetary_policy.pdf

Malovaná, S. Hodula, M. & Rakovska, Z. (2020). *Researching the Research: A Central Banking Edition*. (Research and Policy Notes 3/2020). Czech National Bank, Economic Research Division. https://www.cnb.cz/export/sites/cnb/en/economic-research/.galleries/research_publications/irpn/download/rpn_3_2020.pdf

Marcussen, M. (2006). "Institutional Transformation? The Scientization of Central Banking as a Case Study". In T. Christensen and P. Leagreid (Eds.). *Autonomy and Regulation: Coping with Agencies in the Modern State* (pp. 81–109). Cheltenham: Edward Elgar.

Marcussen, M. (2009). "Scientization of Central Banking: The politics of A-politicization". In K. Dyson and M. Marcussen (eds.) *Central Banks in the Age of the Euro: Europeanization, convergence, and power*. (pp. 373-390) Oxford, UK: Oxford Univ. Press

Mitchell, J (Ed.). (2021). Central Bank Directory 2022. London: Central Banking.

Mongeon, P. & Paul-Hus, A. (2016). The Journal Coverage of Web of Science and Scopus: A Comparative Analysis. *Scientometrics*, *106(1*) pp. 213-228. https://doi.org/10.1007/s11192-015-1765-5

Ochoa, M. & Schmidt-Hebbel, K. (2006). *El Banco Central de Chile en comparación con los Bancos Centrales del Mundo*. (Working Paper No. 367) Banco Central de Chile.

Ortíz, A. (Ed.) (2018). *Monetary Policy and Financial Stability in Latin America and the Caribbean*. (V. 1) XIX Meeting of the Central Bank Researchers Network. Centro de Estudios Monetarios Latinoamericanos, https://www.cemla.org/PDF/ic/2018-jrp-xix.html

Pattnaik, D. Hassan, M. K., Kumar, S. & Justin, P. (2020). Trade Credit Research Before And After The Global Financial Crisis Of 2008: A Bibliometric

Overview, *Research in International Business and Finance,* 54. https://doi.org/10.1016/j.ribaf.2020.101287

R Core Team (2023). R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

Rybacki, J. & Serwa, D. (2021). What Makes a Successful Scientist in a Central Bank? Evidence from the RePEc Database. *Central European Journal of Economic Modelling and Econometrics (3),* pp. 331-357. https://journals.pan.pl/Content/121598/mainFile.pdf

Sarmiento, M. (2010). Central Bank Economic Research: Output, Demand, Productivity, and Relevance. *Money Affairs*, *Center for Latin American Monetary Studies*, 23 (2), pp. 211-240. http://dx.doi.org/10.2139/ssrn.1567149

Schmidt-Hebbel, K. & Carrasco, M. (2019). Central Banking in Latin America. In: *The New Palgrave Dictionary of Economics.* Palgrave Macmillan, London. https://doi.org/10.1057/978-1-349-95121-5_3109-1

Snowdon, B. & Vane, H. R. *Modern Macroeconomics: its Origins, Development and Current State*. Edward Elgar Publishing.

St-Amant, P. Tkacz, G. Guérad-Langlois, A. & Morel, L. (2005). *Quantity, Quality, and Relevance: Central Bank Research, 1990–2003 (Document de travail du personnel No. 2005-37).* Bank of Canada. https://www.banqueducanada.ca/2005/12/document-de-travail-2005-37/

Tombazos, C. G. (2005). A Revisionist Perspective of European Research in Economics. *European Economic Review*, 49(2), pp. 251-277. https://doi.org/10.1016/j.euroecorev.2004.09.011

Trichet, J.-C. (2007, 21st May): *The Role of Research in Central Banks and at the ECB*. [Speech at the Award of the Germán Bernácer Prize Ceremony, Madrid]. http://www.ecb.europa.eu/press/key/date/2007/html/sp070522.en.html

Ugarte, E. León, J. & Parra, G. (2017). La trampa de liquidez, historia y tendencias de investigación: un análisis bibliométrico. *Problemas del desarrollo*, 48(190), pp. 165-188.

Uribe Escobar, J. D. (2008). La investigación económica en el Banco de la República: lecciones a partir de una comparación internacional. *Revista del Banco de la República*, *81* (974), pp. 5-22.

Windsor, C. (2021). The Intellectual Ideas Inside Central Banks: What's Changed (Or Not) Since The Crisis? *Journal of Economic Surveys*, 35 (2), pp. 539-565. https://doi.org/10.1111/joes.12413

Anex

Table A.1. List of banks in CEMLA and search strategies (only WoS strategy is displayed)

Group	Bank country	Strategy used
Associates	Argentina	OO = "Ban* Argentina" OR OO = "central bank of argentina" OR OO = "banco central de argentina" OR OO = "banco central de la republica argentina")
	Barbados	OO = "Ban* Barbados" OR OO = "central bank of barbados"
	Brazil	OO = "Ban* Bra?il" OR OO = "banco central de brasil" OR OO = "banco central do brasil" OR OO = "central bank of brazil" OR OO = CENT BANK BRAZIL
	Chile	OO = "Ban* Chile" OR OO = "banco central de chile" OR OO = "Central Bank of Chile")
	Colombia	OG = "Banco de la Republica de Colombia" OR OO = "Ban* Colombia" OR OO = "Banco de la Rep?blica Colombia"
	México	OO = "Ban* M??ico" OR OO = "banco de mexico" OR OO = "bank of mexico"
	Perú	OO = "Central Bank of Peru" OR OO = "Ban* Per?" OR OO = "banco central de reserva del peru" OR OO = "Central Reserve Bank of Peru"
	Uruguay	OO = "Ban* Uruguay" OR (OO = banco central AND OO = Uruguay) OR (OO = central bank AND OO = Uruguay)
	Venezuela	OO = "Ban* Venezuela" OR (OO = banco central AND OO = Venezuela) OR (OO = central bank AND OO = Venezuela)
Collaborating members	Germany	OO = Bundesbank OR OO = "German Ban*" OR OO = "Deutsche Bundesbank" OR OO = "Bundesbank"
	Canada	OO = "Ban* Canada" OR OO = "bank of canada"
	Spain	OG = "Banco de Espana" OR OO = "Ban* Espa?a" OR OO = "Ban* Spain" OR OO = "bank of Spain"
	United States	OG = (Federal Reserve Bank - Atlanta OR Federal Reserve Bank - Boston OR Federal Reserve Bank - Chicago OR Federal Reserve Bank - Cleveland OR Federal Reserve Bank - Dallas OR Federal Reserve Bank - Kansas City OR Federal Reserve Bank - New York OR Federal Reserve Bank - Philadelphia OR Federal Reserve Bank - Richmond OR Federal Reserve Bank - San Francisco OR Federal Reserve Bank - St. Louis OR Federal Reserve System - USA OR Federal Reserve System Board of Governors) OR OO = "Federal Reserve Bank Minneapolis OR OO = "Federal Reserve Bank Minneapolis
	France	OO = "Ban* France" OR OO = "banque de france" OR OO = "bank of france"
	Italy	OO = "Ban* Italia" OR OO = "Bank Italy" OR OO = "Banca d'Italia" OR OO = "Bank of Italy"
	Portugal	OG = (Banco de Portugal) OR OO = "Ban* Portugal" OR OO = "banco de portugal" OR OO = "bank of portugal"
	Hungary	OO = "Ban* Magyar" OR OO = "Ban* Hungary" OR OO = "Hungarian National Bank"
	Switzerland	OO = "SWISS NATL BANK"

Table A.2. Number of employees by associates and collaborating members

Classification	Bank	No. employees (size) [9]
Associates	Argentina	2368 (2020 July)
	Barbados	220 (2020)
	Brazil	3810 (2018)
	Chile	685 (2019 Dec)
	Colombia	2835 (2021 Jul)
	Mexico	2500 est. (2019) 3322 (2018)
	Peru	923 (2020)
	Uruguay	598 (2020 Dec)
	Venezuela	2727 (2007)
Collaborating members	Germany	10407 (2020)
	Canada	1761 (2019)
	Spain	3359 ((2021 Jul)
	France	9535 (2020)
	Hungary	1470 (2020)
	Italy	6671 (2020)
	Portugal	1777 (2020)
	Switzerland	856 (2021)
	USA	22106 (2019)

9 Mitchell J (Ed.). (2021). Central bank directory 2022 (32nd ed.). London: Central banking.