Researching the Research: A Central Banking Edition*

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We build two unique data sets on the research in central banks in Europe and the United States, offering a novel insight into central banks' research activities, the topics covered, collaborations networks, gender diversity, and research popularization. Even though we identify significant heterogeneity among different regions, we reveal several important stylized facts. Following the global financial crisis, financial stability surpassed monetary policy as the leading research topic. We have also documented a substantial decline in papers with single authors, from 40 percent in 2000 to less than 20 percent in 2019. Still, research in central banks is highly concentrated, as the top 10 percent of authors contribute to about 50 percent of all central banks' research publications. While central banks form enormous research networks, we find that most of this research collaboration is region specific with an increasing representation of women. Nevertheless, the gender gap persists and is closing only slowly. In this respect, small central banks are found to employ more female researchers than large ones. Last but not least, major central banks with a well-established research tradition achieve the highest average impact factor, with a few research papers contributing the most to this average.

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1. Introduction

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. Thus, the question is not whether to conduct research in central banks, but how to organize it, how much to invest in it, and how to assure effective transmission of research outcomes into the policy decisionmaking process. Nowadays, an increasing number of central banks have their own research divisions or whole departments staffed with both junior- and senior-level research economists.[1] This is a manifestation of the general belief that sound policy must build on cutting-edge economic thinking. Moreover, research in central banks has established itself as a prominent contributor to the academic literature over time. Claveau and Dion (2018) show that major monetary economics journals are increasingly dominated by central banks' research papers. Another interesting trend is the visibly increasing share of non-U.S. central bankers who have been invited to the annual Jackson Hole Economic Policy Symposium.[2] This has allowed them to conduct high-level discussions about current topics, to evaluate the ex ante appropriateness of intended measures, and to analyze the efficiency of measures applied.

The literature on central banks (and, more generally, on independent expert organizations) supplies at least two hypotheses that might explain the number of resources going to research today in central banks. First, being perceived as "scientific" organizations might be a huge asset for central banks in their interactions with external actors (elected officials, other regulatory bodies, market

[1]The high level of specialization and proficiency in economics and finance is also apparent from the governor appointments. Lebaron and Dogan (2016) analyze the biographies of 312 incumbent and former central bank governors from across the world, observing a high qualification level, predominantly in economics.

[2]The proportion of market participants fell from 27 percent in 1982 to 3 percent in 2013 as they were "replaced" by non-U.S. central bankers, whose share increased from 3 percent to 31 percent (*The Economist* 2014).

participants, and the general public). High-quality research publications can enhance a central bank's reputation and increase its credibility, making it easier to defend policy actions both publicly and privately.[3] Second, there is an international dynamics inside the central banking community that pushes toward more research through mimicry.[4] The observed scientization of central banks might be akin to a bandwagon effect: a few research-oriented central banks are identified as "successes," which incentivizes other central banks to copy the model and, as the model diffuses, it becomes the thing to do, rationalized by the claim that in-house research makes for better policy (Cecchetti 2002; Trichet 2007; Bolton, Cecchetti, and Reichlin 2014; Carney 2014).[5]

In our paper, we provide an international overview of the research conducted in central banks. We perform our exploration across both the cross-sectional and the time dimension. Specifically, we aim to shed some light on how central banks organize and communicate their research activities, how they perform in terms of research outputs, and what the recent trends are in areas such as the research topics covered, collaborations between central banks and with other institutions, and gender diversity. For this purpose, we create two unique data sets. The first one contains information on central banks' research activities in three main areas: research publications, popularization of research, and organization of research. Each area is evaluated on a number of different factors, together making a list of 26 items. The second data set comprises information about more than 20,000 research papers published in European and U.S. central banks over the period of 2000–19. To the best of our knowledge, neither of these two data sets has previously been constructed. As such, they offer a unique insight into central banks' research activities, allowing us to explore heterogeneity

[3]Literature shows that institutions craft their rhetoric to increase their popularity and protect themselves from audience-based pressures (Maor, Gilad, and Bloom 2013; Gilad, Maor, and Bloom 2015; Moschella and Pinto 2019).

[4]For example, in the early stage of setting up the European System of Central Banks, the U.S. Federal Reserve served as the primary template for research organization (Fase and Vanthoor 2000).

[5]Similar speeches on the importance of research in central banks were given at the end of the millennium as well—see Taylor (1998).

among central banks from different regions and changes in research conducted before and after the global financial crisis (GFC) of 2007–09. Documenting these issues may help central banks to identify best practices.

We complement the existing body of literature along at least three dimensions. First, we add to the literature examining the research conducted in academia. This includes studies that analyze the formation of research networks among academics (Adams 2012) and studies commenting on the demographics and trends in the articles published in economic journals (Card and DellaVigna 2013; Hamermesh 2013). Our paper verifies whether some of the trends observed in academic research regarding the number of coauthors, network density, distribution of authorship, and others are also present in central banks' research. In this respect, our findings largely complement those of Essers, Grigoli, and Pugacheva (2020), who employed data on 6,152 International Monetary Fund (IMF) working papers written in the period of 1990–2017, including authors' names and e-mails, number of pages and citations, and JEL codes, using the IMF website catalogue. In addition, they complemented the data with employee-level information. Our analysis offers a rather different perspective, as it includes an international sample of central banks and supranational institutions, while it supports many of the findings of Essers, Grigoli, and Pugacheva (2020). Second, our paper echoes the literature on central bank communication (Dincer and Eichengreen 2007; Blinder et al. 2008) by offering a unique view on how research—one of the underlying processes behind policy decisionmaking—is conducted. Third, we contribute to the growing body of literature on gender gaps in central banks (Charléty, Romelli, and Santacreu-Vasut 2017; Diouf and Pépin 2017) by studying the gender structure of research teams.

The rest of the paper is organized as follows. Section 2 describes two unique data sets on central banks' research. Section 3 discusses the main purpose of research in central banks and categorizes the main research activities performed by them. Section 4 gets more into the detail and presents a few stylized facts on the topics researched in central banks, authorship networks, the gender structure of research teams, and the impact factor of central banks' publications. Section 5 concludes.

2. Data Sets on Central Banks' Research Activity

We construct two unique data sets allowing us to explore various attributes of research in central banks.[6] We focus our attention on two regions—the United States and Europe. The U.S. Federal Reserve is a reference on its own in the world of central banks, especially in terms of its research (Claveau and Dion 2018). Numerous testimonies from European central banks (the European Central Bank notwithstanding) confirm that they aim(ed) to emulate the Fed and the Anglo-Saxon tradition in terms of research powers (Fase and Vanthoor 2000; Mudge and Vauchez 2016). The two regions thus form a good sample to study, as they are likely to share important similarities.[7] According to the IDEAS/RePEc ranking of top 25 percent central banks in terms of research, our sample covers 28 out of 32 central banks listed as of January 2022. Given such a large coverage, the patterns found for our sample of central banks may be generalized also for other jurisdictions. We complement these regions with data on two additional international institutions, namely the Bank for International Settlements (BIS) and the European Central Bank (ECB, also including the European Systemic Risk Board, ESRB), as both encompass research activities serving policy conduct in central banks.[8] Altogether, we compile information on 55 central banks. We include all 12 regional Federal Reserve Banks in the Federal Reserve System and the Federal Reserve Board (FRB) and 40 European national central banks. Within Europe, we further distinguish between three regional areas—the euro area original members (EA orig.), Western and Northwestern Europe (W & NWE), and Eastern and Southeastern Europe and the Baltic Countries (E & SEE, BC; see Table 1). We hypothesize that research quantity, quality,

[6] Both data sets, including code used for their construction, are available at https://simonamalovana.org/.

[7] In the construction of the data sets, we needed to find a compromise between data accessibility and a related amount of labor and relative sample homogeneity. Recent data suggest that economists from the U.S. Federal Reserve Banks, international financial institutions, and euro zone central banks are cited more frequently than economists with similar characteristics from central banks located in emerging markets (Rybacki and Serwa 2021).

[8] We deliberately restrict other high-ranked research-oriented institutions from our sample, such as the IMF or the World Bank, because they are not perceived as central banks nor are their functions related to central bank policy conduct.

Table 1. Division of Central Banks in Europe into Regions

	Euro Area Original Members (EA Orig.)		Western and Northwestern Europe (W & NWE)		Eastern and Southeastern Europe, and Baltic Countries (E & SEE, BC)	
Research Score Data Set and IDEAS/RePEc Data Set	AT	Austria	DK	Denmark	AL	Albania
	BE	Belgium	IS	Iceland	BG	Bulgaria
	DE	Germany	NO	Norway	CY	Cyprus
	ES	Spain	SE	Sweden	CZ	Czech Republic
	FI	Finland	SW	Switzerland	EE	Estonia
	FR	France	UK	United Kingdom	GR	Greece
	IE	Ireland			HR	Croatia
	IT	Italy			HU	Hungary
	LU	Luxembourg			LT	Lithuania
	NL	Netherlands			LV	Latvia
	PT	Portugal			MK	North Macedonia
					MT	Malta
					PL	Poland
					RO	Romania
					RS	Serbia
					SK	Slovakia
					SL	Slovenia
					UA	Ukraine
Only Research Score Data Set					BA	Bosnia and Herzegovina
					BY	Republic of Belarus
					MD	Republic of Moldova
					ME	Montenegro
					XK	Republic of Kosovo

Note: The Research Score Data Set includes an additional five central banks in Europe which report some characteristics of their research but do not have any public research publication series, or the series is very short, or the publications are not in English.

and collaboration, among other things, will be different between the regions. For instance, we assume a more dense collaboration network within the euro area original members, reflecting a longer period of cooperation via various working groups and research networks. Furthermore, we assume the higher quality of research conducted by central banks in W & NWE relative to E & SEE, BC due to a long tradition of research in both central banks and academia. As such, the differentiation between these regions will help us to explore the potential heterogeneity.

The first data set leverages information available on each of the 55 central banks' websites and social media accounts. The data set (hereafter referred to as the Research Score Data Set) comprises information on central banks' research activities in three main areas: research organization, publications, and popularization. Each area is evaluated using several different factors, together making a list of 26 items (see Table A.1 in Appendix A). The items include, for example, the types of research publication series, the extent of research opportunities offered, the level of autonomy of the research departments, and the degree to which U.S. and European central banks use their websites, social media (Twitter, LinkedIn, and YouTube) and additional forms of communication such as blogs, newsletters, and bulletins to promote the research. Out of the 26 items, 21 were harvested from banks' websites and four from banks' social media accounts, and the last item was collected as a single observation from the IDEAS/RePEc website (see the next paragraph). The data were collected during the observation period of February–March 2020 and should therefore be interpreted as of these months. Each item is assigned a score of between 0 and 1: 1 if the bank engages in the given activity in full; 0.50/0.25 if the activity is in place only partially; and 0 otherwise. To obtain a separate measure for each of the three areas and a single overall measure for all 26 items, the research scores are constructed as the sum of the scores assigned to the individual items; the individual items are not weighted. As such, we get an *overall research score*, a *research organization score*, a *research publication score,* and a *research popularization score.* All the scores are calculated on the level of individual central banks and visualized in the form of a geographical heat map (see Figure 2 and Figure B.1 in Appendix B).

The second data set comprises information about more than 20,000 research papers published in 50 central banks over the period of 2000–19.[9] This data set was extracted from the IDEAS/RePEc website using the web-scraping technique, and it includes the paper's title, the authors' names and reported affiliations, the abstract, keywords and JEL codes, and an indication of whether the paper has been published in a scientific journal.[10] We harvested information on working paper series, discussion paper series, and occasional paper series, and on other research publication series similar to those three (for instance, research publication series with a special focus, such as Monetary Policy Committee (MPC) discussion papers or financial stability papers).[11] The final data set (hereafter referred to as the IDEAS/RePEc Data Set) went through numerous controls to ensure its completeness and correctness. Nevertheless, it was not possible to extract and match all information. For example, it is not possible to match the author to his or her affiliation if the name listed in the paper differs from the name registered in the database (if it has changed due to marriage, for example). It is also not possible to match a working paper to its journal version if the title has changed significantly. Moreover, not all the harvested information is reported for each research paper. For instance, abstracts are assigned to more

[9]Five central banks in Europe which report some characteristics of their research but do not have any public research publication series, or the series is very short, or the publications are not in English, were omitted from the second data set.

[10]The data were extracted from the IDEAS/RePEc database during the first half of 2020. As such, it represents the information which applies to the date on which it was collected. For example, the author's affiliation represents the affiliation reported by her at that time. As such, it does not represent a historical record of the affiliations to which the author reported at the time of paper's publication. A scientific journal is any publication series referred to as a journal by IDEAS/RePEc. As such, it includes central banks' in-house journals (e.g., the Federal Reserve Bank of Richmond's Economic Brief, FRBSF Economic Letter, Bulletin de la Banque de France, or Visnyk of the National Bank of Ukraine) that represent less than 1 percent of all journal publications.

[11]The publication series were selected based on their research character so as to create a more or less homogeneous group, which means that rather short and analytical publication series were not included. We also excluded in-house journals, as these are by their nature closer to scientific journals than working paper series. Moreover, if the working paper (discussion paper, occasional paper, etc.) is then published in the central bank's in-house journal, it is indicated in our sample.

than 99.6 percent of publications, keywords to about 83 percent, and JEL codes to about 78 percent. About 69 percent of all authors have an assigned affiliation. In addition, the data are subject to the completeness and quality of reporting by central banks, listed journals, and authors themselves. A few central banks in Europe either do not report their research publications in the database at all or do not have such a series. Therefore, some information was harvested manually where available to complete the coverage of European countries (see Table A.2 in Appendix A). We excluded entries with non-English abstracts (only about 2.3 percent) and we expanded the IDEAS/RePEc Data Set with some additional information on impact factor and the gender of the authors. Gender is identified using the R package *gender* based on the authors' first name (85 percent of all first names are recognized and assigned a gender with an average probability (precision)[12] of 98 percent). Impact factors, as reported by the IDEAS/RePEc database, are assigned both to the central banks' research publication series and to the scientific journals in which some of the research papers are published.

3. How to Understand and Organize Research in Central Banks

The views on what constitutes research may vary—both across different central banks and even among the employees of a bank. For some, "research" can be virtually any longer-term project intended to contribute to the work of the bank. For others, the term describes the work that is published, either in a central bank series or academic journal. Of course, in some institutions, research can have also negative connotations as a project with little or no relevance for addressing any practical policy questions (Meyer et al. 2008).[13] For the purpose of this paper, the term research refers to the systematic study of a question using scientific methods aimed at expanding

[12]The gender is inferred using historical data sets of first names and dates of birth. In this way it is possible to report the probability that a name was male or female. For more details, see the documentation on the package.

[13]Meyer et al. (2008) in their report noted that "the Committee [the External Review Committee of economic research activities at the Bank of Canada] discovered that the term 'research' has a very wide range of meanings for many senior managers as well as staff economists at the Bank."

the general state of knowledge, with more or less direct relevance to policymaking.[14]

Both basic and applied research should be present in central banks, as they complement each other. Basic research is generally tasked with thoroughly investigating a problem to push back the frontiers of knowledge. Applied research, on the other hand, is supposed to have an immediate use and visible value added. Although basic research may not have any immediate application, it may have positive long-term spillovers for the institution and for the economy as a whole. One type of research cannot (or should not) live without the other. Basic research provides fundamental knowledge that applied research can build upon. Likewise, basic research benefits from specific improvements and new fundamental questions generated by applied research. In the context of central banking, basic research is motivated by a desire to increase understanding of the fundamental principles grounding the institution. Such research can try to understand and review, for example, the central bank's role in society, its contribution to public welfare, its aim and impact, or the functioning of the whole economy, including financial institutions and financial markets. Applied research, on the other hand, is usually designed to answer a specific research question aimed at an immediate application. This can include, for example, assessing the transmission of a particular monetary, macroprudential, or supervisory policy instrument, or developing and refining a particular methodology, model, or indicator.

Research in central banks usually stands somewhere between basic and applied research. Policymakers appreciate frontier thinking but are generally more interested in research that addresses practical issues faced by the central bank. This is where the two types of research may clash. With basic research, value added is mainly assessed by some form of publication metric, such as the impact factor of the journal publication. However, applied research tends to

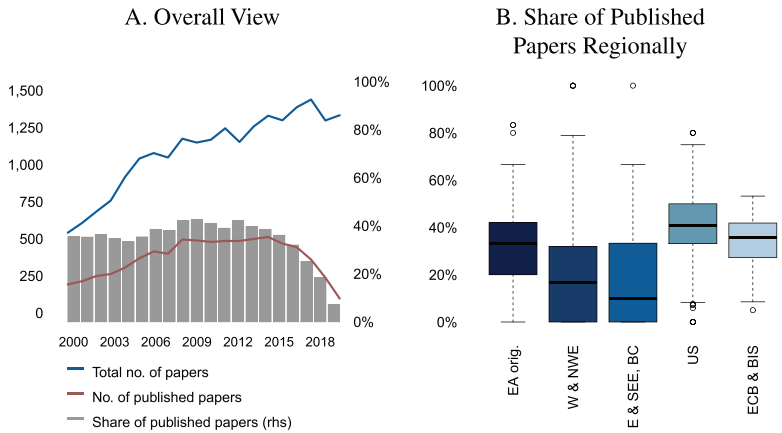
[14]It remains an open question how to draw a line between short-term analytical tasks and research projects. If we adopt the perspective that research is eventually meant to be published, analytical tasks addressing specific policy questions with no expectation of generating any publishable research output would not be viewed as research. Nevertheless, we highlight that both analytical tasks and research are intertwined and complementary. Analytical tasks are typically informed by current research and sometimes can spur new research topics themselves.

address aspects of less interest to journal editors and may not even be meant for journal publication in the first place. This is apparent from Figure 1, which shows that the average share of central banks' research papers published in scientific journals is close to 40 percent and rising only slightly over time (see Figure 1, panel A).[15] On top of that, the heterogeneity among central banks is quite pronounced (see Figure 1, panel B). Assessing the merits of applied research is thus much more difficult. 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 society. They can serve as a strong conceptual and empirical basis for conducting monetary policy and maintaining price and financial stability but research publications also help to increase central banks' transparency and sometimes even autonomy. Mudge and Vauchez (2016) argue that the ECB used its research and academic credentials to affirm its leadership in the Eurosystem and build its capacity to work autonomously from national central banks.

In-house research in central banks has value added along multiple dimensions. First, there are the *direct* benefits. Research can aid policymakers in dealing with current policy issues, such as determining the driving factors of current phenomena, analyzing the impact of measures taken, and quantifying the implications of alternative policy choices. Under the same category, research is well suited to deal with future policy issues as well. Second, there are plenty of *indirect*, often overlooked, benefits. High-quality research publications can enhance a central bank's reputation and increase its credibility and make it easier to defend policy actions both publicly and privately (Issing 2005; Dincer and Eichengreen 2007; Blinder et al. 2008). A modern central bank strives to be predictable to the market most of the time and extensively communicates its decisions to the public. Moreover, having high-quality research is self-sustaining, as the central bank has a greater chance of attracting (and keeping) high-quality economists. These benefits are important to maintain, even at the cost of letting some research time be spent on topics outside the central bank's mandate.

[15]The noticeable decline in working papers published in journals since 2014 is due to publishing delays (Björk and Solomon 2013).

Figure 1. Share of Central Banks' Research Papers Published in Scientific Journals

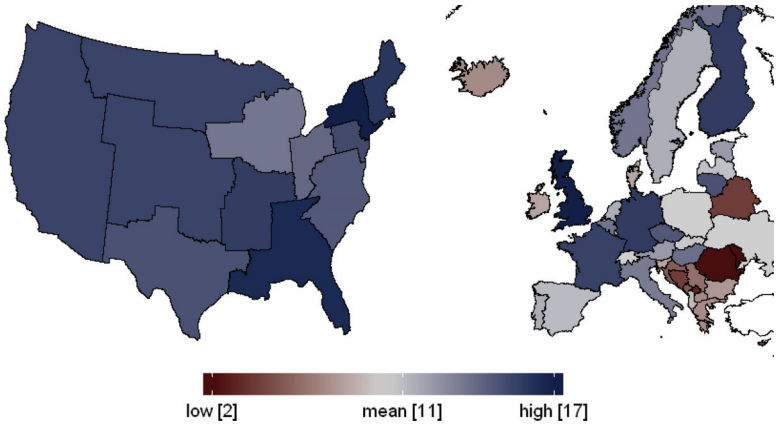


Note: Panel A: The total number of research papers published by the 50 central banks in their own publication series between 2000 and 2019 is 21,908; the total number of central banks' research papers published in scientific journals is 7,455. Panel B: Each point of the distribution refers to the share of central banks' research papers published in scientific journals in the given year between 2000 and 2019. In four instances the share is 100 percent, with the number of working papers produced being only one or two in a given year and for a given central bank.

There is a high degree of heterogeneity as to the amount of research activities carried on by individual central banks. The research activities performed by central banks are not limited to publications only. Figure 2 depicts the degree of engagement in various research activities, summarized in the *overall research score*, for all the national central banks in our sample (see Section 2). The maximum score is 17 (Bank of England) and the minimum is 2 (the central banks of Romania and the Republic of Moldova). The difference is especially pronounced between central banks in Eastern and Western Europe, with a higher *overall research score* achieved in the West (see Figure 2). Nevertheless, there are three exceptions—the Czech National Bank,[16] the Central Bank of Hungary, and the Bank

[16]For more details on the Czech National Bank's research model, see Malovaná (2020).

Figure 2. Overall Research Scores of Central Banks—United States and Europe



Note: The information was collected manually using the central banks' websites and social media accounts. The detailed data behind the scores can be found in the working paper version of this article (Malovaná, Hodula, and Rakovská 2020) and in Table A.1. The choropleth maps do not reflect the scores for the Federal Reserve Board (FRB), the European Central Bank (ECB, including the ESRB), and the Bank for International Settlements (BIS).

of Lithuania, which all exhibit an above-average *overall research score*. Even though each of these three central banks achieves its high score by different means (i.e., by engaging in a different set of research activities), all of them are catching up quite well with the well-established and more research-oriented central banks in Europe. Unsurprisingly, all the Federal Reserve Banks achieve a high *overall research score* of between 12.5 and 16.75, reflecting the high importance assigned to research in the system. All these institutions are recognized for their intense investment in scientific prestige and scholarly research.

The *overall research score* consists of three sub-indices—a *research organization score*, a *research publication score,* and a *research popularization score*. Each of the following subsections focuses on one area (for more details on the sub-indices, see Appendix A).

3.1 Research Organization in Central Banks

The vast majority of the central banks in our sample have a separate research department.[17] Most of these departments (divisions, units) fall under the area of monetary policy, forecasting, or general economic analysis. Even though the majority of the central banks in our sample (28 out of 55) have a legal mandate to maintain financial stability, only a few of them have reflected this in the organizational structure of their research activities. Only eight central banks have their own financial research department—three among the U.S. Federal Reserve banks; four among the central banks of the E & SEE, BC region; and the ECB.

Some central banks have affiliated research institutes, which usually focus on a special economic topic (for example, the Bank of Finland Institute for Economies in Transition or the Consumer Finance Institute at the Federal Reserve Bank of Philadelphia). The purpose of such affiliated institutes is to conduct high-quality research and to act as a center of excellence for the selected area. The activities of affiliated centers are usually performed by researchers drawn from across the central bank, but there are also some institutes formed of employees from academia only (the Einaudi Institute for Economics and Finance created by the Bank of Italy) and institutes with a mixture of the two (the Center for Excellence in Finance and Economic Research at the Bank of Lithuania).

3.2 Publication Activities of Central Banks

Central banks publish their research outcomes in various publication series. The most prevalent form of research publication series are working paper series (28 out of 40 central banks in Europe and all 12 Federal Reserve Banks), discussion paper series (8 central banks in Europe), and occasional paper series (5 central banks in Europe). In addition, many central banks also use more specific series, such as technical publications (Research Technical Papers—Central Bank of Ireland), policy-related publications (Research and

[17]There are six central banks for which we report no research unit, five of them located in the E & SEE, BC region (Bosnia and Herzegovina, Croatia, Republic of Kosovo, Romania, and Ukraine) and one, the Central Bank of Iceland, in the W & NWE region.

Policy Notes—Czech National Bank), or finance-related publications (Financial Stability Papers—Bank of England; Banking and Financial Studies—Deutsche Bundesbank). An overview of central banks' publication series can be found in Table A.2 in Appendix A.

The *research publication score* summarizes information not only on the existence of such a series but also on open-source research data and the presentation of central banks' publication activity via its own website and via IDEAS/RePEc. A number of central banks publicly share their research data,[18] which then creates a positive externality, as it allows other researchers to replicate the results or to follow up on that research. Nevertheless, these activities are dominated by the U.S. Federal Reserve Banks (11 out of 12), while there are only 5 central banks in Europe that share their research data publicly.[19] Next, a number of central banks promote successful placement of their papers in peer-reviewed journals on their websites. This tendency, however, is recognized mainly across the U.S. Federal Reserve Banks.[20]

3.3 Research Popularization in Central Banks

Central banks are dedicating more and more resources to communicating and enhancing the visibility of their research. Popularization is an important part of overall research activities, as it connects the central bank and its researchers to the wider society. There are a number of ways of increasing the visibility of research outcomes; we have identified three sets of such activities within central banks: (i) use of social media, (ii) a separate webpage (or section of a website) dedicated to research, and (iii) additional forms of presentation or communication, such as blogs, newsletters, and bulletins.

First, central banks are becoming more active on social media. Almost all central banks in Europe (except for the Central Bank of Montenegro) and all the U.S. Federal Reserve Banks use at least

[18] We consider here only research data that can be shared publicly. Naturally, some data used in central bank publications cannot be publicly shared due to confidentiality reasons.

[19] Denmark, Germany, Lithuania, the Netherlands, and the United Kingdom.

[20] Even though almost all the central banks in our sample successfully placed at least one research paper in a scientific journal, only 30 percent of central banks in Europe report that on their websites.

one social media platform as a modern channel of communication. The most frequently used social media among central banks are Twitter and LinkedIn. The majority of these central banks even have their own YouTube channel. Many of these central banks use social media for research popularization. This trend is more common and more frequent among the U.S. Federal Reserve Banks and larger central banks in Europe with a well-established research tradition. Moreover, five U.S. Federal Reserve Banks (New York, Philadelphia, Richmond, St. Louis, and Cleveland) and two national central banks in Europe (the Bank of England and the Bank of Finland) have established a separate Twitter account exclusively for posts about research work. All in all, the U.S. Federal Reserve Banks use social media for research purposes much more than European central banks. We find the lowest share in the E & SEE, BC region, where only 22 percent of banks advertise their research work on social media, while the share is 92 percent for the U.S. region (including the Federal Reserve Board). Table A.3 in Appendix A further shows a very similar pattern for the intensity with which central banks that use their social media for research purposes utilize their accounts in general (e.g., the number of Twitter tweets or the number of years since joining the media as a whole). The situation changes when one examines the popularity of these central banks' social media profiles. For example, central banks in the W & NWE region, as well as ECB & BIS, have on average a larger number of Twitter and LinkedIn followers compared to U.S. banks, and surprisingly, all the European regions outrun the United States in the average number of YouTube video views.

Second, central banks are leveraging the potential of their websites to increase the visibility of their in-house research. The majority of central banks in Europe (80 percent), all the U.S. Federal Reserve Banks, the ECB, and the BIS have a separate webpage (or section of a website) dedicated to research activities.[21] They use this website to highlight research topics prioritized by the central bank (more than 50 percent of the central banks in our sample),[22] to promote

[21]Seven banks in the E & SEE, BC region and one central bank in the EA orig. region have no research website.

[22]More than 67 percent of central banks in Europe engage in such activity, while only 42 percent of the U.S. Federal Reserve Banks do so.

research events such as conferences and workshops (94 percent), to offer some form of fellowship or traineeship (60 percent), and to communicate opportunities for external collaboration (64 percent). Central banks are less active when it comes to the organization of research competitions and awards (20 percent, mostly from the E & SEE, BC region) and calls for projects (14 percent). Central banks also promote these activities via social media or conventional media. Another way to increase the visibility of research is via individual researchers' profiles, which provide a more personalized view. Central banks may use this tool to boost the scientific prestige of their research staff. All the U.S. Federal Reserve Banks and the majority of central banks in Western Europe (including the ECB and the BIS) promote their researchers on their websites. However, less than one-third of central banks in the E & SEE, BC region follow this practice.

Third, some central banks are exploiting the potential of additional forms of presentation and communication, such as research blogs, bulletins, and newsletters. These types of presentation rarely offer new information, but they do summarize existing research outcomes and activities in a more "digestible" (i.e., shorter, simpler, and non-technical) form. The use of these additional forms of presentation and communication of research outcomes is concentrated in the United States and Western Europe. Only about one-third of central banks in the E & SEE, BC region use one or more of them. Research newsletters are the most common among these three (employed by 55 percent of central banks in our sample). However, they take the form usually of a simple e-mail notification about website updates (67 percent) and less frequently of an original document (23 percent are e-mail campaigns; 10 percent are new research publications). Research blogs and research bulletins are less common. Only about one-third of central banks in the United States and Western Europe use research blogs, and about one-quarter of these central banks publish research bulletins.

4. Research in Central Banks: Some Stylized Facts

There is a significant heterogeneity in research publication activity among central banks from different regions. Table 2 presents

Table 2. Summary Statistics—IDEAS/RePEc Data Set

	EA Orig.	W & NWE	E & SEE, BC	USA	ECB & BIS	Total
No. of CB Research Papers	6,692	1,880	1,982	8,161	3,193	21,908
No. of Journal Publications	2,147	520	399	3,252	1,137	7,455
No. of Authors	4,741	1,512	1,577	4,069	1,433	13,332
of which:						
Female Authors	1,201	316	429	867	307	3,120
Male Authors	2,586	936	724	2,653	894	7,793
Registered in IDEAS/RePEc	2,253	799	713	2,206	621	6,592
of which:						
With Multiple Affiliations	620	155	184	514	158	1,631
With Affiliation to CB	1,008	471	371	727	276	2,853
With Affiliation to CB and at Least One Other Affiliation	197	76	112	187	34	606

(*continued*)

Table 2. (Continued)

	EA Orig.	W & NWE	E & SEE, BC	USA	ECB & BIS	Total
Mean and Standard Deviation						
Share of CB Research Papers Published in Journals	32.8	27.4	15	40.4	30.8	27.7
	(6.5)	(14.3)	(9.2)	(7.5)	(7.1)	(13.4)
Publications per Author	1.6	1.4	1.3	2.2	1.9	1.6
	(0.5)	(0.3)	(0.3)	(0.4)	(0.6)	(0.5)
Male to Female Authors Ratio	2.5	3.3	2.1	3.4	3.5	2.7
	(0.8)	(1.0)	(2.3)	(0.6)	(1.0)	(1.6)
Share of Authors Registered in IDEAS/RePEc	48.5	55.6	37.6	58.4	43.3	51.6
	(7.6)	(24.4)	(22.9)	(9.5)	(3.4)	(20.2)
of which:						
With Multiple Affiliations	14.3	10	8.9	14.4	11.1	11.9
	(3.9)	(3.4)	(6.3)	(4.6)	(0.2)	(5.5)
With Affiliation to CB	21.5	34.1	23.1	18.2	13.3	26
	(7.5)	(25.8)	(17.2)	(2.6)	(10)	(20.3)
With Affiliation to CB and at Least One Other Affiliation	4.9	4.1	6.8	5.5	1.8	5.6
	(2.7)	(1.5)	(5.5)	(3.4)	(1.2)	(4.2)

Note: The data are subject to completeness and quality of reporting by central banks, journals, and authors themselves. They cover the 2000–19 period. Standard deviations are in parentheses. CB—central bank; EA orig.—euro area original members; W & NWE—Western and Northwestern Europe; E, SEE & BC—Eastern and Southeastern Europe, and Baltic countries. For more details on the composition of each geographical region, see Table 1; for more details on the data themselves, see Section 2.

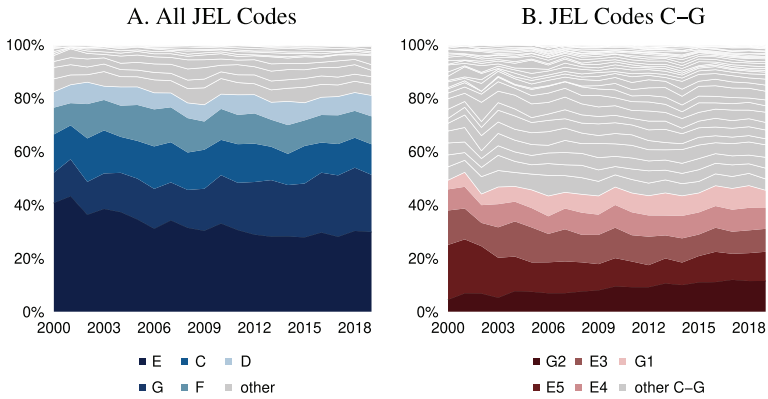
basic summary statistics for the IDEAS/RePEc Data Set used in the rest of this section (see Section 2). The U.S. Federal Reserve Banks, including the FRB, achieve the highest figures in most categories, reflecting the important role of research in the U.S. system. The share of research papers published by the U.S. Federal Reserve Banks and the FRB in scientific journals between 2000 and 2019 is more than 40 percent. Central banks in the original EA member states and supranational institutions (the BIS and the ECB, including the ESRB) have shares about 10 percentage points lower. The U.S. region has the highest number of publications per author, reflecting higher productivity and/or an opportunity to devote more time to research. Fairly similar "productivity" can be observed in the BIS and the ECB. The U.S. region shows a relatively high share of authors with multiple affiliations, which translates to stronger collaboration networks (see Subsection 4.2) with positive synergies for the quantity and quality of research outcomes. However, the male-to-female authors ratio is the second worst among the regions, with 3.4 times more male than female authors (see also Subsection 4.3).

4.1 Topics Researched in Central Banks

In terms of JEL codes, the broad research areas selected by central banks are fairly stable over time, reflecting central banks' core activities. Unsurprisingly, more than half of the research falls into two categories—*E: Macroeconomics and Monetary Economics* and *G: Financial Economics* (see Figure 3, panel A).[23] This reflects the two main objectives—price stability and financial stability—and the two main sets of instruments—monetary policy and prudential policy—usually assigned to central banks. Even though some central banks may not be directly assigned the goal of financial stability, they have to be interested in the pursuit of this goal, because any disruption to financial institutions and financial markets has a direct impact on the monetary policy transmission mechanism (Smets 2014). The third most common area of research according

[23]In contrast, Essers, Grigoli, and Pugacheva (2020) report that almost half of all the IMF working papers published in the period 1990–2017 address research topics connected to *E: Macroeconomics and Monetary Economics* or *F: International Economics*.

Figure 3. JEL Code Analysis

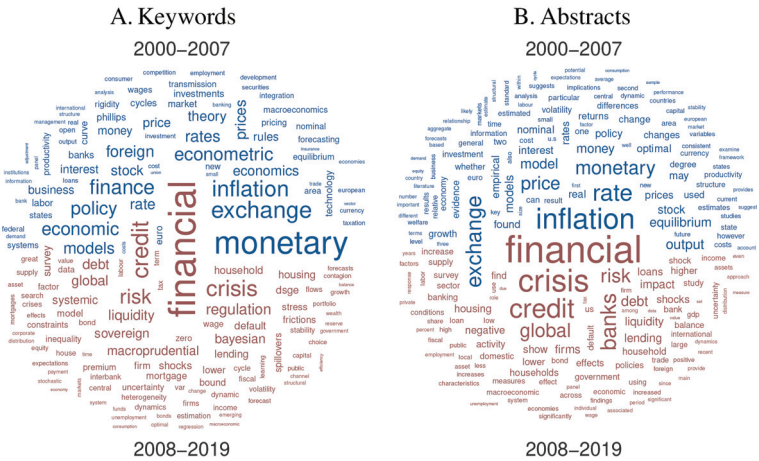


Note: The figure depicts the percentage of publications with a particular JEL code assigned. E: Macroeconomics and Monetary Economics; G: Financial Economics; C: Mathematical and Quantitative Methods; F: International Economics; D: Microeconomics; G2: Financial Institutions and Services; E5: Monetary Policy, Central Banking, and the Supply of Money and Credit; E3: Prices, Business Fluctuations, and Cycles; E4: Money and Interest Rates; G1: General Financial Markets.

to JEL codes is *C: Mathematical and Quantitative Methods*. This reflects the strong rigorous basis of the policy decisionmaking process in central banks, and consequently the need for quantitative research inputs into the policy discussion. A more detailed breakdown of JEL categories shows that the main focus of central banks' research is indeed on financial institutions and financial markets, monetary policy, prices and business cycle fluctuations, and money, credit, and interest rates (see Figure 3, panel B).

Following the GFC, financial stability has emerged as the leading research topic. A simple word cloud of keywords and words in abstracts shows that central banks' research agenda *before* the GFC focused mostly on monetary policy issues and macroeconomic topics in general, such as inflation targeting, exchange rate dynamics, convergence, and unemployment (see Figure 4, upper blue part). Following the outbreak of the GFC in 2008, the topics visibly changed in favor of the macro-finance area (see Figure 4, lower red part). The leading research agenda *after* the GFC is related to financial

Figure 4. Word Cloud Before and After the GFC

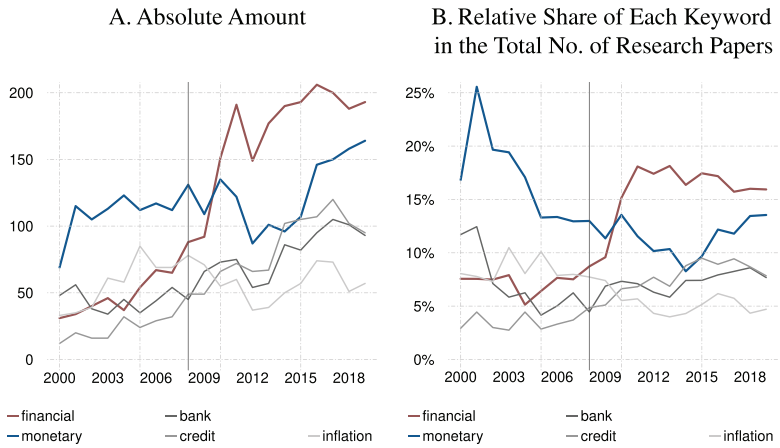


Note: Only keywords (the most frequent words in abstracts) with a minimum count of 150 (1,500) are included. The upper (blue) part of the clouds reflects the period 2000–07, while the lower (red) part refers to the period 2008–19. We report word clouds based on both keywords and abstracts because about 17 percent of the publications in our sample do not report keywords, while more than 99 percent report abstracts.

stability policy conduct, with numerous papers analyzing the role of credit dynamics and performing financial risk assessments.

Looking at the dynamics of the five most common keywords, we spot some long-term trends reflecting economic developments and policy challenges (see Figure 5). First, the keywords nicely mirror changes in policy mandates. That is obvious from the increasing dominance of the keywords "financial," "credit," and "bank." These keywords reflect the rising interest of central banks in research topics related to the conduct of financial stability policies. There is an apparent structural break that occurred somewhere around the outbreak of the GFC in 2008. This is when the relative share of *financial* issues overtook that of *monetary* issues. Second, we document a rather stable role of *inflation*-related topics in relative terms. The absolute number of the keyword "inflation" has been gradually rising since 2000, reflecting the fact that the majority of the central banks analyzed operate in fully fledged inflation-targeting regimes.

Figure 5. Five Most Common Keywords in Central Banks' Research Papers



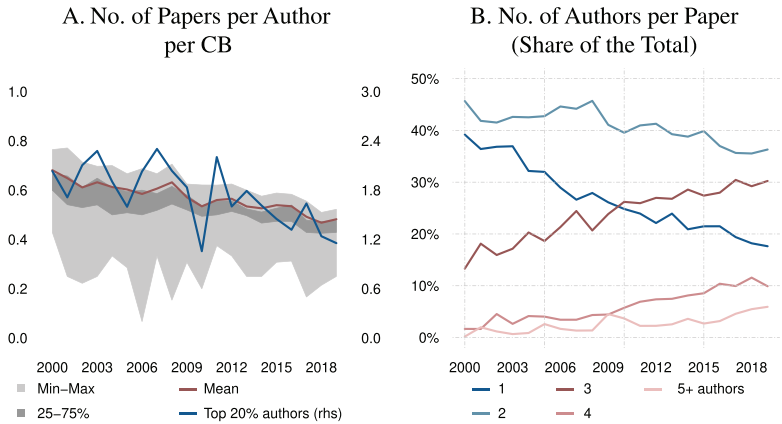
Note: Panel A: Based on 18,256 research papers with keywords published by all European, U.S., and supranational central banks as indicated in Section 2 in period 2000–19. Panel B: Relative share is calculated as the ratio between the frequency of each keyword and the total number of research papers with reported keywords in every given year.

Cumulatively, the first five words appear in 46 percent of all central banks' research papers with reported keywords over the period analyzed.

4.2 Authorship Networks

Research in central banks is heading towards a more collaborative environment. We follow Adams (2012) and consider authorship as a proxy for research collaboration. While the number of publications per author per central bank is decreasing steadily over time (see Figure 6, panel A), the number of authors per publication is increasing (see Figure 6, panel B). What is most striking is the drop in the share of publications with a single author from 40 percent in 2000 to less than 20 percent in 2019. The share of publications with exactly three authors, on the other hand, has more than doubled in the last two decades, reaching 30 percent in 2019. It is also becoming increasingly common to have publications with four

Figure 6. Collaboration Between Researchers

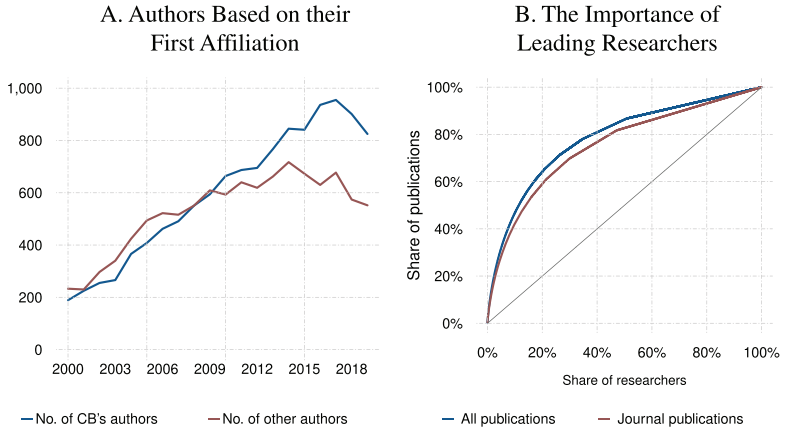


Note: Panel A: Calculated as the number of research publications published by the central bank in the given year divided by the number of authors participating in the research publications in the given year. Panel B: Calculated as the number of publications with the given number of authors in the given year divided by the total number of publications in the given year.

and five or more authors. This is consistent with the general tendency in economic research identified by numerous studies over the last couple of years (see, for example, Card and DellaVigna 2013; Hamermesh 2013; Kuld and O'Hagan 2018; Essers, Grigoli, and Pugacheva 2020).[24] The rising number of collaborators is generating positive knowledge spillovers not only to the direct collaborative partners (Azoulay, Graff Zivin, and Wang 2010; Borjas and Doran 2015) but also indirectly to other researchers who are connected to

[24]Using article information from the top five and top three economic journals, respectively, Card and DellaVigna (2013) and Hamermesh (2013) show that the distribution of the number of authors has shifted steadily rightward. Specifically, Card and DellaVigna (2013) report that the number of authors per paper increased from 1.3 in 1970 to 2.3 in 2012. This is confirmed by Kuld and O'Hagan (2018) on a large sample of the top 255 economic journals. They show that the share of multi-authored papers increased from 50 percent in 1996 to over 75 percent in 2014. Similarly, by studying the history of IMF Working Papers, Essers, Grigoli, and Pugacheva (2020) found that both the number of authors publishing within the IMF and the number of publications issued in the IMF have increased over the last few decades, with the former having the faster pace.

Figure 7. Authors Affiliation and the Role of Leading Researchers



Note: Panel A: The absolute number of authors affiliated either with the central bank or with some other institution (based on the first reported affiliation if there are multiple ones). Panel B: The percentage share of individual authors (researchers) in the total number of authors in our sample in relation to the percentage share of publications authored by these researchers in the total number of publications in our sample.

them within a complex network (Hsieh et al. 2018). Among other things, there is compelling evidence that teaming up is good for individual productivity (Ductor et al. 2014; Ductor 2015; Kong et al. 2019). Although the number of authors involved in central bank research is growing steadily, the importance of a relatively small number of top researchers remains high (see Figure 7, panel B).

Next, we study the collaboration networks at the level of individual institutions. We calculate the bilateral connections between authors based on their reported affiliation in IDEAS/RePEc database and the central bank in which the research paper was published. As such, each edge in our network represents a collaborative connection while the nodes are individual institutions. The width of the edges reflects the total number of collaboration relationships in a given period. For the purposes of our analysis, we divide the sample into five-year non-overlapping periods that allow us to avoid exceptional cases in the evolution of the network and observe changes

over time. To make the network more visually tractable, we divide the resulting analysis into three parts. First, we take a closer look at the collaboration networks formed by central banks in the European region. Second, we focus on the Federal Reserve System in the United States.[25] Third, we analyze the cooperation networks that are formed by central banks with institutions other than central banks (e.g., universities, research institutes, and international organizations).

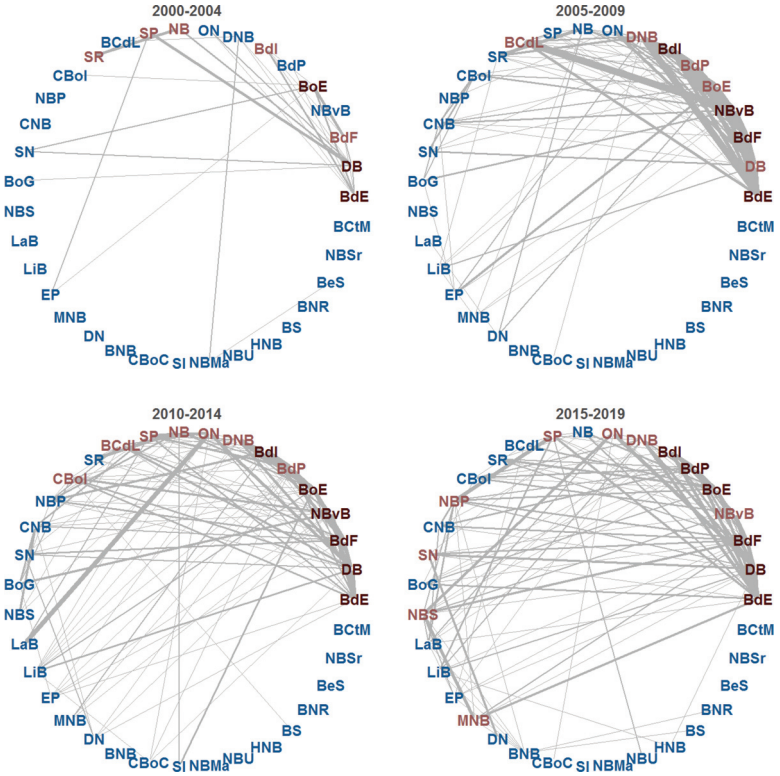
Central banks form enormous research networks. Research collaboration between national central banks in Europe has grown considerably over time. There is a distinct difference in the density of the collaboration network between the first and the second decade analyzed (see Figure 8). Over the first five-year period (2000–04), just eight central banks accounted for 80 percent of all publications, of which only three central banks—the Bank of England, Deutsche Bundesbank, and Banco de España—accounted for 50 percent of all publications. During the subsequent five-year period (2005–09), the cooperation between these institutions intensified, while some formerly isolated central banks joined the research network. The central banks that increased their collaboration with the leading research cluster the most were from Central Europe (Poland and the Czech Republic) and the Baltic region (Estonia and Lithuania).

The density of the research collaboration network increased significantly in the years following the GFC (see Figure 8). This may have been due to several factors combined. First, it may have been the outcome of an increase in knowledge integration, especially in the new EU member states that joined the European Union (EU) in 2004, 2007, and 2013. The European System of Central Banks (ESCB), which consists of all EU national central banks and the ECB, encompasses many research networks and working groups that are meant to stimulate interaction between researchers and promote information exchange.[26] Second, the GFC, among other

[25]Supranational institutions (ECB and BIS) and their connections to national central banks in individual regions are depicted separately in Figure B.2 in Appendix B.

[26]Past and present examples of such platforms include the Household Finance and Consumption Research Network (HFCN), the Euro Area Business Cycle Network (EABCN), the Wage Dynamics Network (WDN), and the Macroprudential Research Network (MaRs). See "Research Networks" on the ECB's website.

Figure 8. Collaboration Networks Between Central Banks—Europe



Note: Each edge between two central banks (nodes) represents authors affiliated with one of the two central banks whose paper was published in the other central bank. The width of the edge reflects the total number of such authors. As such, the width of the edges does not reflect the total number of research papers between the two central banks but rather the total number of collaboration relationships. Central banks shown in red account for 80 percent of publications (dark red for 50 percent and light red for the additional 30 percent).

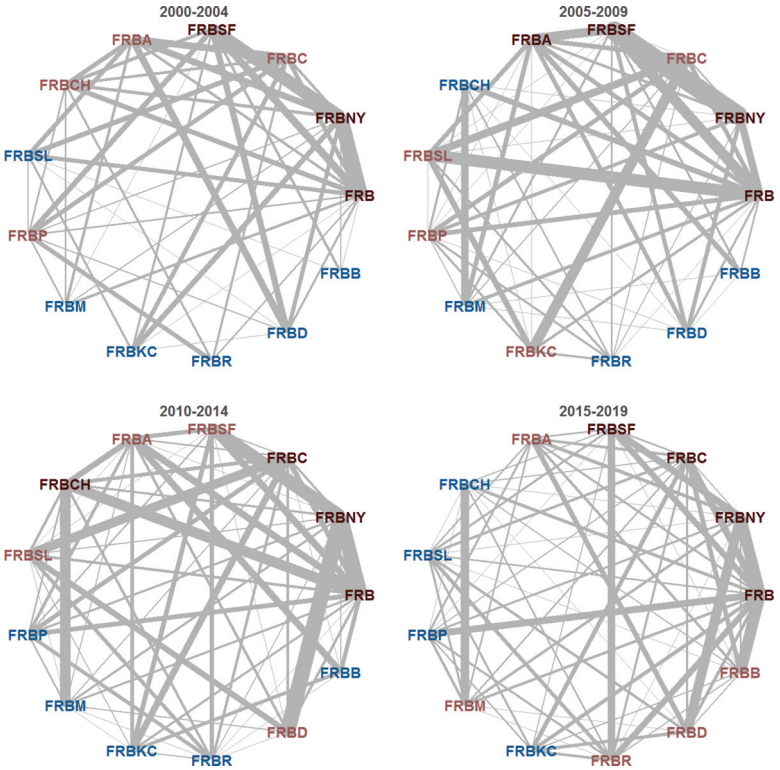
BoE: Bank of England; CNB: Česká Národní Banka; BdI: Banca d'Italia; BdE: Banco de España; BdF: Banque de France; SR: Sveriges Riksbank; NB: Norges Bank; SP: Suomen Pankki; BdP: Banco de Portugal; CBoI: Central Bank of Ireland; ON: Oesterreichische Nationalbank; DNB: de Nederlandsche Bank; SN: Schweizerische Nationalbank; DB: Deutsche Bundesbank; LiB: Lietuvos Bankas; LaB: Latvijas Banka; EP: Eesti Pank; NBP: Narodowy Bank Polski; NBS: Národná Banka Slovenska; MNB: Magyar Nemzeti Bank; BoG: Bank of Greece; CBoC: Central Bank of Cyprus; CBCG: Centralna Banka Crne Gore; NBoU: National Bank of Ukraine; NBS: Narodna Banka Srbije; NBnRSM: Narodna Banka na Republika Severna Makedonija; SI: Sedlabanki Íslands.

things, revealed a dark side of highly connected financial markets (Stiglitz 2010; Haldane and May 2011; Acemoglu, Ozdaglar, and Tahbaz-Salehi 2015; Acharya et al. 2017). The fact that dense interconnection serves as a mechanism for the propagation of shocks is now widely acknowledged. As a result, researchers in central banks have begun to form more intense scientific networks, which has led to shared knowledge, data points, and even whole databases.

The U.S. Federal Reserve System is a complex collaborative network of individual reserve banks, with a few leading the research activities. The density of the research collaboration network has remained very high throughout the two decades (see Figure 9) with no significant difference before and after the GFC. The U.S. network is much richer and more evenly distributed than the European network. In the United States, we do not identify any "lost sheep," as all of the individual Federal Reserve Banks and the FRB have established strong collaborations with the rest. In terms of the authorship counts, we can identify a cluster of four U.S. central banks that can be (historically) considered the leading ones, accounting jointly for 50 percent of the total publications—the Federal Reserve Bank of San Francisco, the Federal Reserve Bank of Chicago, the Federal Reserve Bank of New York, and the Federal Reserve Board.

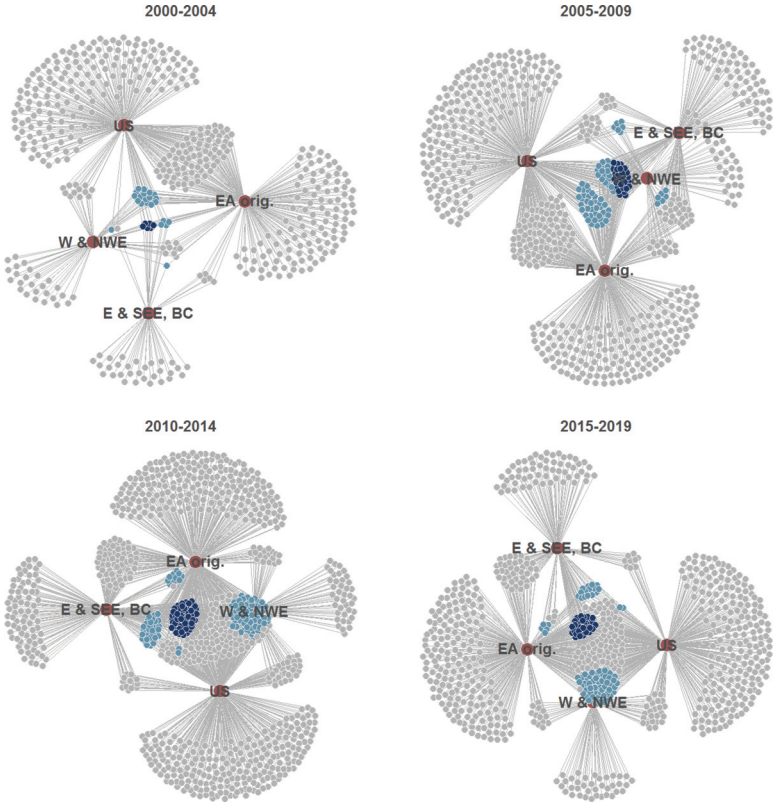
The U.S. Federal Reserve Banks and the national central banks in Europe maintain fruitful collaborations with academia and other research institutions (see Figure 10). Most of this research collaboration is region specific, meaning that central banks usually collaborate with institutions in their own countries or regions (such as national universities). A relatively small set of institutions collaborate with central banks in all four regions (in dark blue) or in three out of the four regions (in light blue). The institutions with the most authored publications with central banks are renowned research institutes and universities (see Figure 11). In the United States, these are the National Bureau of Economic Research (NBER), the Institute of Labor Economics (ILE), the Centre for Economic Policy Research (CEPR), and the University of Pennsylvania (Penn). Another of the most active research collaborators with the U.S. Federal Reserve Banks is the International Monetary Fund (IMF). Other academic collaborators hail mostly from U.S. universities. Surprisingly, there are also some important links to universities outside the United States, namely the Universita Commerciale Luigi Bocconi

Figure 9. Collaboration Networks Between Central Banks—United States



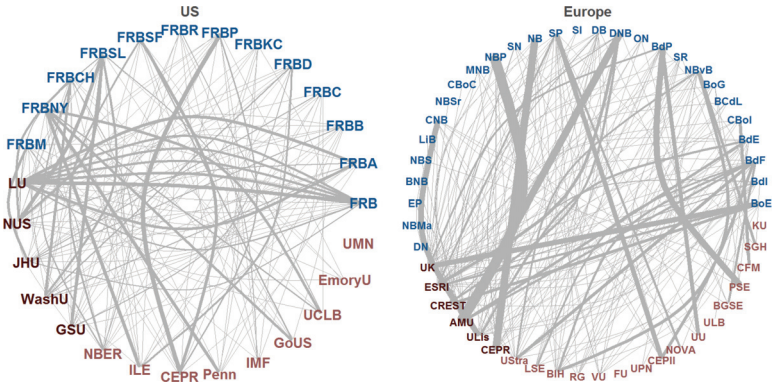
Note: Each edge between two central banks (nodes) represents authors affiliated with one of the two central banks whose paper was published in the other central bank. The width of the edge reflects the total number of such authors. As such, the width of the edges does not reflect the total number of research papers between the two central banks but rather the total number of collaboration relationships. Central banks shown in red account for 80 percent of publications (dark red for 50 percent and light red for the additional 30 percent).
FRB: Federal Reserve Board (Board of Governors of the Federal Reserve System); FRBA: Federal Reserve Bank of Atlanta; FRBB: Federal Reserve Bank of Boston; FRBCH: Federal Reserve Bank of Chicago; FRBC: Federal Reserve Bank of Cleveland; FRBD: Federal Reserve Bank of Dallas; FRBKC: Federal Reserve Bank of Kansas City; FRBM: Federal Reserve Bank of Minneapolis; FRBNY: Federal Reserve Bank of New York; FRBP: Federal Reserve Bank of Philadelphia; FRBR: Federal Reserve Bank of Richmond; FRBSF: Federal Reserve Bank of San Francisco; FRBSL: Federal Reserve Bank of St Louis.

Figure 10. Collaboration Networks Between Central Banks and Other Institutions



Note: Each grey node represents one institution other than the central bank with which the authors in our sample are affiliated. Central banks are divided into four regions and represented by dark red nodes. Each edge represents authors affiliated with an institution other than the central bank whose paper was published in the central bank in the given region. The width of the edges does not give any information in this case. Central banks shown in red account for 80 percent of publications (dark red for 50 percent and light red for the additional 30 percent). Institutions with authored publications with central banks in all four regions are shown in dark blue; institutions with authored publications with central banks in three out of the four regions are shown in light blue.

Figure 11. Institutions with Most Authorships with Central Banks (top 1 percent)



Note: The top 1 percent of institutions based on the number of collaborations with central banks between 2000 and 2019. Each edge represents authors affiliated with an institution other than the central bank whose paper was published in the central bank. The width of the edge reflects the total number of such authors. As such, the width of the edges does not reflect the total number of research papers between the two but rather the total number of collaboration relationships. Central banks are shown in blue. Institutions with more than 150 collaborations with central banks over the period 2000–19 are shown in dark red. LU: Lindenwood University; NUS: National University of Singapore; JHU: Johns Hopkins University; WashU: Washington University in St. Louis; GSU: Georgia State University; NBER: National Bureau of Economic Research; ILE: Institute of Labor Economics; CEPR: Centre for Economic Policy Research; Penn: University of Pennsylvania; IMF: International Monetary Fund; GoUS: Government of the United States; UCLB: Universita Commerciale Luigi Bocconi; EmoryU: Emory University; UMN: University of Minnesota.
UK: Univerzita Karlova v Praze; ESRI: Economic and Social Research Institute; CREST: Centre de Recherche en Économie et Statistique; AMU: Aix-Marseille Université; ULis: Universidade de Lisboa; CEPR: Centre for Economic Policy Research; UStra: Université de Strasbourg; LSE: London School of Economics; BIH: BI Handelshoyskolen; RG: Rijksuniversiteit Groningen; VU: Vrije Universiteit Amsterdam; FU: Fordham University; UPN: Université Paris-Nanterre; CEPII: Centre d'études prospectives et d'informations internationales; NOVA: Universidade Nova de Lisboa; UU: Universiteit Utrecht; ULB: Université Libre de Bruxelles; BGSE: Barcelona Graduate School of Economics; PSE: Paris School of Economics; CFM: Centre for Macroeconomics; SGH: Szkola Glówna Handlowa w Warszawie; KU: KU Leuven.

and the National University of Singapore. In Europe, most authorship relations are found for the CEPR, while the rest are top-shelf European universities. The CEPR is also the single most important collaborator for all four regions considered.

As pointed out by Claveau and Dion (2018), the relationship between researchers from central banks and those from other research institutions can be considered a two-way stream. On the one hand, central banks actively invite other researchers to collaborate on policy-related topics, which may be pursued either via various visiting research programs or by direct cooperation with these institutions. On the other hand, researchers in central banks are entitled to spend some time on basic research in addition to applied (policy-oriented) research. This allows them to collaborate on topics which may be of greater interest to academics.

Looking at the authorship network connections from a different angle may give us a bird's-eye view of researchers' mobility. As mentioned above, the networks presented are formed of collaborative connections between central bank in which the research paper was published and the authors based on their affiliation. The affiliations reported in the IDEAS/RePEc Data Set usually reflect the *current* institutional assignment of the authors, as they are directly from the authors' profiles on the IDEAS/RePEc website. However, the publication itself is historically linked to a given central bank. As such, the affiliations recorded in this publication are fixed, regardless of the authors' mobility across institutions. For most research papers, it can be expected that at least one of the authors was affiliated with the given central bank at the time of publication. Therefore, if the reported affiliations of all the authors differ from the publishing central bank, it is very likely that at least one author has changed her affiliation since then. Panel A in Table 3 provides the numerical representation of network graphs presented in this section.[27] In contrast, panel B employs the approach which disregards the information about the publishing central bank and takes into account only information about authors' affiliations. Comparing panel A and panel B gives a rough estimate of researchers' mobility between central banks and from central banks to other research institutions.

[27]If the author reports affiliations to multiple institutions, a relationship pair is created for each of the institution–central bank pair.

Table 3. Number of Collaborations Among Central Banks and Between Central Banks and Other Research Institutions

	EA Orig.	E & SEE, BC	W & NWE	ECB & BIS	US	Other Institutions
A. Based on Author's Self-Reported Affiliation and Publishing Central Bank						
EA Orig.	22,133 (27.0%)	1,819 (2.3%)	956 (1.2%)	5,555 (6.8%)	3,813 (4.7%)	7,175 (8.8%)
E & SEE, BC		2,499 (3.1%)	42 (0.1%)	1,522 (1.9%)	279 (0.4%)	1,821 (2.3%)
W & NWE			3,268 (4.0%)	559 (0.7%)	294 (0.4%)	1,957 (2.4%)
ECB & BIS				9,869 (12.1%)	595 (0.8%)	3,728 (4.6%)
US					4,537 (5.6%)	9,574 (11.7%)
B. Based Purely on Author's Self-Reported Affiliation						
EA Orig.	3,099 (6.2%)	240 (0.5%)	108 (0.2%)	3,317 (6.6%)	333 (0.7%)	7,352 (14.7%)
E & SEE, BC		762 (1.5%)	22 (0.0%)	483 (1.0%)	26 (0.1%)	1,899 (3.8%)
W & NWE			533 (1.1%)	339 (0.7%)	140 (0.3%)	1,807 (3.6%)
ECB & BIS				12,806 (25.5%)	531 (1.1%)	5,123 (10.2%)
US					2,916 (5.8%)	8,307 (16.6%)

Note: Panel A: The counts represent network connections between the publishing central bank and the authors' affiliations. Panel B: The counts represent network connections between the authors' affiliations regardless of the publishing central bank. The percentage share in parentheses is calculated as the individual counts divided by the total number of network connections.

Even though it is not possible to track each individual movement of researchers between central banks and to other research institutions, this comparison provides at least a simplified view of this trend.

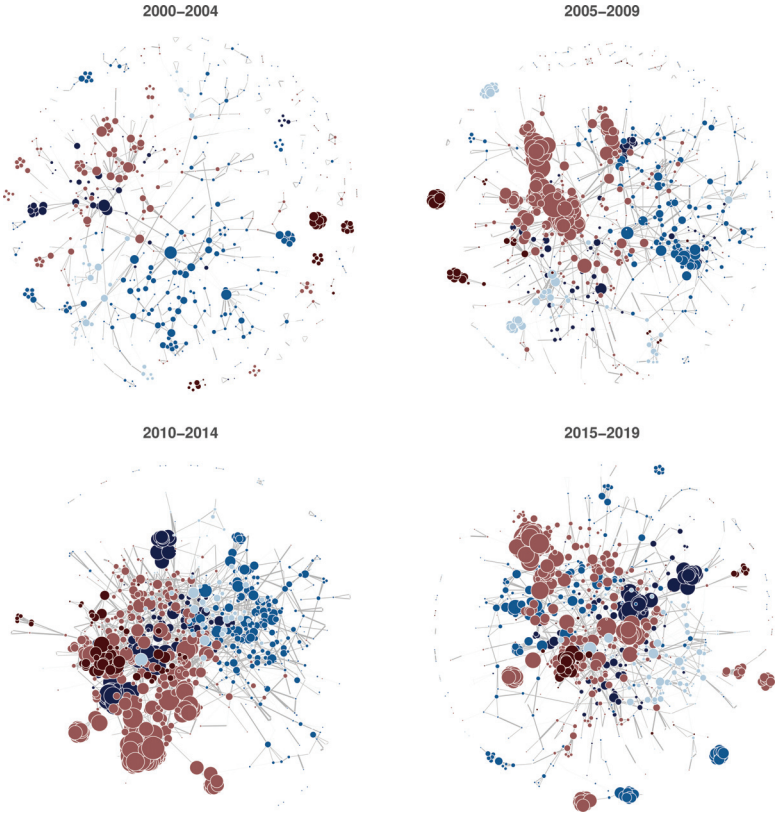
The distribution of collaborative connections calculated based on the two approaches differs between regions, indicating researchers' mobility to the ECB, the BIS, and academia. Taking into account the publishing central bank (the first approach), the most network connections exist between authors from the group of original euro area member states, followed by the ECB and BIS and connections to other research institutions (see Table 3, panel A). These make up about 70 percent of all network connections.[28] By the nature of the calculation, the second approach yields fewer network connections on aggregate than the first one. However, we can see that the absolute number of connections has increased significantly for the ECB & BIS–ECB & BIS bucket, and also for some collaboration pairs with other research institutions (see Table 3, panel B). This most likely reflects higher mobility to these institutions. In particular, the result suggests that researchers tend to leave national central banks for supranational institutions and for research institutions other than central banks.[29]

Finally, we complement the networks formed based on researchers' self-reported affiliation with a network looking at the collaborations based only on publishing central banks. Figure 12 shows a collaboration network between individual authors—nodes. The size of the node reflects the number of collaborative relationships of each author, i.e., the number of other authors with whom she collaborated on her research papers. Authors (nodes) are divided into five groups based on the region of the central bank which published

[28]Twenty-seven percent for the EA orig.–EA orig. bucket, 12.1 percent for the ECB & BIS–ECB & BIS bucket, and 29.8 percent for all connections with other research institutions.

[29]The mobility towards these institutions is also apparent from higher relative shares of network connections (the numbers in parentheses in Table 3). The relative share is significantly higher in panel B than in panel A in the ECB & BIS–ECB & BIS bucket and the ECB & BIS–EA orig. bucket, and for most connections with other research institutions. Besides researchers' mobility, the difference between the two approaches may also reflect researchers affiliated with the ECB & BIS or other research institutions publishing their papers in national central banks without the collaboration of researchers from national central banks. However, we consider this highly unlikely or limited in scope.

Figure 12. Collaboration Networks Between Authors



Note: Each node represents one author in our data sample. The size of the nodes reflects the number of relationships of the author, i.e., the number of other authors with whom she collaborated. Authors (nodes) are divided into five groups based on a central bank that published the paper they collaborated on. Authors shown in dark red published mainly in ECB or BIS; authors shown in light red published mainly in U.S. central banks; authors shown in dark blue published mainly in central banks from EA orig. region; authors shown in middle blue published mainly in central banks from W & NWE region; authors shown in light blue published mainly in central banks from E & SEE, BC region. For ease of exposition, only authors with a certain number of publications are shown in the figure (2000–04: at least 3 publications; 2005–09: at least 5 publications; 2010–14: at least 15 publications; 2015–19: at least 9 publications). Each edge between two authors (nodes) represents publications between the two authors. The width of the edges reflects the number of publications between the two authors.

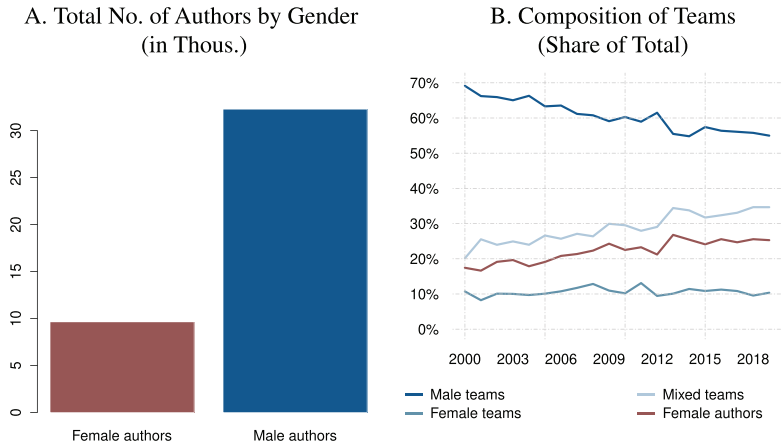
the paper. The width of the edges connecting individual nodes then reflects the number of publications between each pair of authors.

A few paragraphs earlier, we highlighted a significant contribution of a relatively small number of top researchers to the final population of research papers (Figure 7). Such evidence can point to the presence of a small world effect (Goyal, Van Der Leij, and Moraga-González 2006) or a superstar effect (Hsieh et al. 2018). In the small world, a few key ("superstar") researchers are shown to bridge the gap between institutions. In particular, Hsieh et al. (2018), when defining a "superstar" researcher, takes into account the spillover effects of one researcher on others in a collaboration network. Figure 12 shows that the network between researchers in our data set becomes denser over time, with a few visible clusters in all regions. The importance of a few researchers (in terms of the number of connections to others) is visible, especially in the United States. Over time, a group of researchers with a significant number of connections has also grown in other regions, notably in central banks in the euro area (dark blue) and the ECB and the BIS (dark red). However, from a simple visual inspection, these clusters appear to be concentrated in a single region, which is consistent with Table 3, indicating that most or a significant proportion of interactions between researchers are within a given region.

4.3 Gender Structure of Authorship Teams

Research also continues to be male dominated, but the trend is changing. In absolute terms, men make up about two-thirds of all the authors of the central bank research papers under study (see Figure 13, panel A). However, the share of female authors has risen significantly over time, reaching 25 percent at the end of 2019 (see Figure 13, panel B). This trend is driven by an increasing share of mixed teams (involving both women and men), reflecting greater collaboration among researchers and larger research teams in general (see Section 4.2). Kwiek and Roszka (2021) show that mixed teams tend to be more successful in publishing in more prestigious journals. While Boschini and Sjögren (2007) find that women are less likely to coauthor than men, we are witnessing that the trend is changing (albeit at a slow pace), at least in central banks' research. Still, all-male research teams continue to dominate, with a more than

Figure 13. Distribution of Authors by Gender

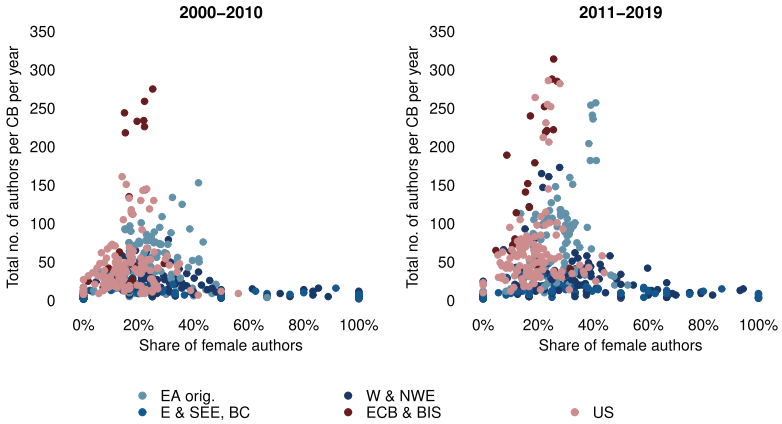


Note: Gender of authors identified based on their first name using the R package *gender* and the related database; see Section 2.

50 percent share of all teams in 2019. Increasing number of studies show that in terms of research performance, the differences between male and female scientists can be explained by the relative skewness of the distribution (Nielsen 2017; Abramo, Aksnes, and D'Angelo 2021). Auriol, Friebel, and Wilhelm (2020) argue that it is important to monitor the gender gap in research, because the topics favored by female economists might deviate from those favored by men. If women are less represented in research teams, then these topics might become systematically under-invested. Furthermore, Zhang et al. (2020) identify significant gender differences in the benefits arising from engagement in international academic collaboration.

Small central banks engage more female researchers. The relationship between the share of female authors and the total number of authors per central bank per year seems to follow a downward-sloping convex curve (see Figure 14). However, this relationship differs between regions. Smaller central banks in Europe (in terms of total number of authors) engage more female researchers. On the other hand, central banks in the United States and in the EA original member states employ a lower share of female researchers. A similar pattern was observed by Auriol, Friebel, and Wilhelm (2020),

Figure 14. Relationship Between the Share of Female Authors and the Total Number of Authors



Note: Gender of authors identified based on their first name using the R package *gender* and the related database; see Section 2.

who showed that the more prestigious the research institution is, the fewer female economists are present. The authors also found that this systematic under-representation is present already at entry level and that the ranking of the institution causes the gap to be even wider.

Central banks rank in the lower half of research and development (R&D) institutional sectors in terms of the proportion of women in research. Table 4 shows that the private non-profit, government, and higher-education sectors exhibit higher shares of female researchers than central banks, while the lowest percentage is recorded by the business enterprise (BE) sector. In 2015–17, women made up more than 40 percent of the research population in the private non-profit, government, and higher-education sectors. These three sectors together employed more than 99 percent of all researchers in the EU as of 2018 (European Commission 2019), which suggests a gradually closing gap. Nevertheless, women are still vastly under-represented in business enterprise research.[30] That central banks lie somewhere

[30]One of the possible drivers of this result is the constant shortage of female graduates (and also doctoral graduates) in the several narrow fields of science,

Table 4. Share of Female Researchers in Different Sectors (%)

	Central Banks	Business Enterprise Sector	Gov. Sector	Higher Education Sector	Private Non-profit Sector
Europe Total	27.0	19.9	40.1	39.6	44.2
EA Original Members	26.7	19.1	38.9	37.6	45.0
W and NW Europe	26.2	20.5	38.4	43.3	42.0
E and SE Europe, and BC	31.7	23.8	43.8	40.5	41.1
2000–04	21.5	18.2	35.5	32.8	40.1
2005–09	25.9	19.2	39.3	41.2	43.5
2010–14	28.2	20.3	41.4	41.2	44.7
2015–17	29.5	21.0	43.8	43.1	49.1

Note: The data cover the period of 2000–17. Unlike the IDEAS/RePEc Data Set, the Eurostat database contains data on only 16 E & SEE, BC countries: BG, CY, CZ, EE, GR, HR, HU, LT, LV, MK, MT, PL, RO, RS, SK, SL. Figure 13 refers to data on the whole sample (including the United States, the ECB, and the BIS); therefore, it may differ slightly from the numbers in this table.

between the shares for business enterprises and higher education is not surprising. Based on OECD (2015, p. 90), the R&D activities of corporations from the financial sector and its sub-sectors, and hence also central banks' R&D activities, fall under either of the two R&D categories. A growing share of women can be observed also among doctoral graduates, as the average annual growth rate of female doctoral graduates in the EU was 2.4 percent between 2007 and 2016, while that of male doctoral graduates was only 1.4 percent (European Commission 2019).

This comparison should be taken with caution, because the figures for central banks refer to authors of research papers, while those for other sectors represent the headcount of R&D personnel as reported in the enterprise survey.[31] Nevertheless, by assuming that researchers usually present their results in the form of a research paper, this can be considered a reasonable approximation.

4.4 Impact Factor

The impact factor is a standard measure for assessing the academic quality of a scientific publication. In fact, this is much more common for academic publication series than for central banks' publication series. Although we cannot say that central banks' publications with a higher impact factor have higher policy relevance[32] (to our knowledge, there is no such indicator), the impact factor can be an important measure of "value for research." Central banks' publication series with higher impact factors are cited more in scientific publications and by other working papers, which indicates the extent to which other researchers find in these series material inspiring their own work.

technology, engineering, and mathematics (STEM) (Huyer 2015; European Commission 2019). Research in these fields covers a significant portion of business enterprise research, so it is reasonable to assume that this broadly discussed issue also affects the gender disparity in science.

[31]The data are gathered via national questionnaires in paper and/or electronic format, and the statistical unit used is enterprise. R&D personnel include all those engaged directly in the R&D activities of the given enterprise (https://ec.europa.eu/).

[32]By policy relevance we understand, in a broad sense, that a central bank paper becomes one of the inputs into a policy decisionmaking process.

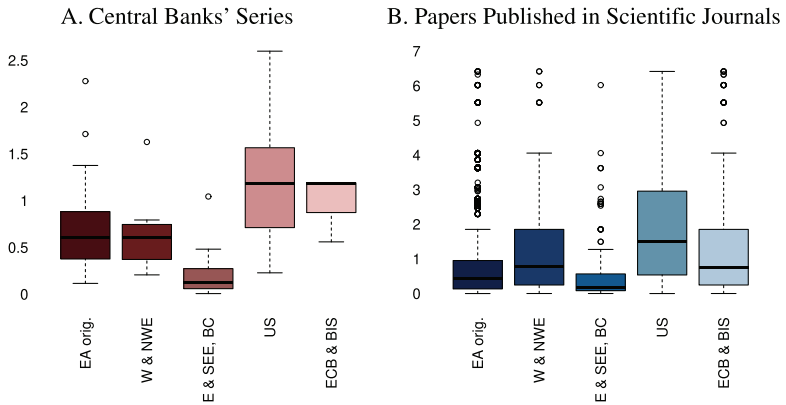
The impact factor[33] of central banks' research publications varies substantially both between and within the regions. Not surprisingly, the ECB, the BIS, and the U.S. Federal Reserve Banks, including the FRB, receive the highest impact factors for their in-house research publication series (see Figure 15, panel A). The recorded dispersion is relatively large in the case of the U.S. region, ranging from as little as 2 to 16.[34] When considering only those papers which have been published in scientific journals, we find the U.S. region on top, followed by the two supranational institutions and the W & NWE region (see Figure 15, panel B). The fact that the U.S. Fed has a higher rate of influence on journal publications is not surprising. Historically, American economists contributed by far the largest share of journal publications and were cited much more often than European economists (Frey and Eichenberger 1993; Rybacki and Serwa 2021). In addition, U.S. research institutions and academic journals in economics are of a higher rank (Kalaitzidakis, Mamuneas, and Stengos 2003, 2011) than those located in Europe and, as such, the U.S. academic market is much bigger. Thus, we might be witnessing the effect of both quality and quantity. Central bank researchers can be schooled at top-tier universities with a long tradition of top economic research and have access to a wide range of top-tier academic outlets to publish their papers.

Interestingly, there is a high correlation between the impact factor assigned to the central banks' research publication series and the average impact factor of the papers published in scientific journals (see Figure 16). The impact factors of the U.S. Federal Reserve Banks and the FRB and the ECB and the BIS reflect the high emphasis placed on research in these institutions, the high share

[33]We present a recursive impact factor, as reported in the IDEAS/RePEc database. However, when compared to other types of impact factors (simple impact factor and a discounted impact factor), the conclusions remain the same. The simple impact factor is calculated as the number of all citations of papers in a particular series or journal divided by the number of papers in the series or journal (self-citations are not considered). The recursive impact factor is calculated in the same way, except that each citation carries some weight. The discounted impact factor gives more weight to what is cited now. For more details, see Zimmermann (2012).

[34]The Federal Reserve Bank of San Francisco and the Federal Reserve Bank of New York rank the highest, while the Federal Reserve Bank of Cleveland and the Federal Reserve Bank of Kansas City rank the lowest.

Figure 15. Recursive Impact Factor—Regional Distribution

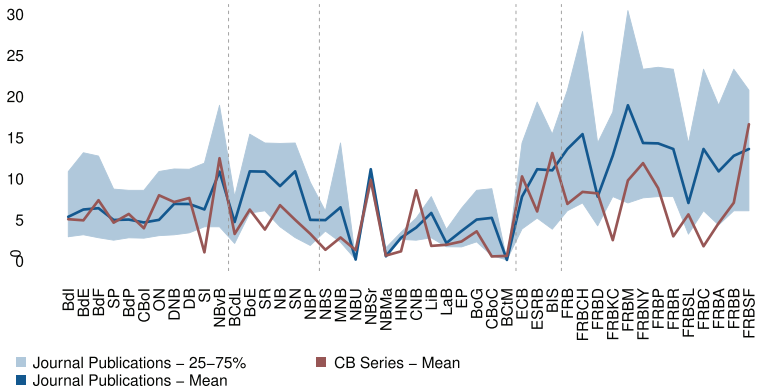


Note: Panel A: The recursive impact factor assigned to central banks' publication series (working paper series, discussion series, occasional papers, etc.). Panel B: The distribution of the non-zero recursive impact factor assigned to the scientific journals in which the central banks' research papers were published. It accounts for 7,411 papers between 2000 and 2019 in total (data as of March 2020). Distribution with simple and discounted impact factor is similar (available upon request).

of researchers from academia involved in the research, and the related high importance given to publishing in high-impact journals. Another significant factor contributing to the relatively high average impact factor is the fact that research papers on the U.S. economy (and other large economies or international samples) generally have a higher probability of publication in a high-impact scientific journal. It is usually harder to publish small country-specific research or applied research which is of interest to a particular central bank but little interest to an international scientific journal.

The impact factor is an important measure of the scientific performance of academic journals, even though some studies have pointed to its problematic nature (Seglen 1997; Simons 2008; Vanclay 2012). The impact factor is derived from the number of citations received by the papers in a particular series or journal. As such, it may help researchers and others in searching for bibliographic references to a particular paper and enable mutual communication.

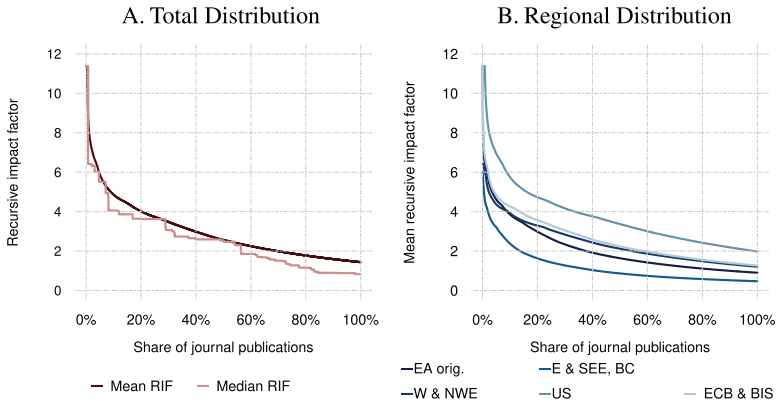
Figure 16. Simple Impact Factor—Individual Central Banks



Note: The interquantile range and mean in blue refer to the non-zero simple impact factor assigned to the scientific journals in which the central banks' research papers were published. The dark red line refers to the simple impact factor assigned to the central banks' publication series. Horizontal lines separate individual regions as follows: EA orig.; W & NWE; E & SEE, BC; ECB & BIS; and US. Only central banks with publication series with an impact factor assigned in the IDEAS/RePEc database are reported. Recursive and discounted impact factors are reported in Appendix B.

It is also an appropriate indicator of research interest, i.e., the extent to which what is published in a series or journal is valued by future research. However, the informative value of the impact factor may be limited, since a small number of papers published in a series or journal may have received a large proportion of the citations. The overall impact factor is then boosted by this small share of papers and may say a little about the quality of the other papers published in a particular series or journal. This pattern is also visible in our data, which show that a very small proportion of central banks' research papers published in scientific journals contribute the most to the average and median impact factor (see Figure 17, panel A). The same pattern persists if we divide the sample into individual regions, with a heightened effect in the United States, the ECB, and the BIS (panel B). These central banks are the ones with the highest average impact factors of their in-house publication series.

Figure 17. Importance of Publications in High Recursive Impact Factor Journals



Note: The distribution with simple and discounted impact factor is equivalent (available upon request).

5. Conclusions

In this paper, we explore research in 55 central banks in Europe and the United States, focusing on the quantity and quality of publication activity, topics analyzed, the cooperation networks between individual central banks and with academia, the gender structure of research teams, and research popularization. For this purpose, we employ two unique data sets containing information on different aspects of central banks' research and more than 20,000 research papers published in these central banks over the 2000–19 period.

There is significant heterogeneity in research activities across central banks from different regions. This heterogeneity is most apparent between larger, well-established central banks with a long research tradition (usually located in the United States and Western and Northwestern Europe) and smaller central banks (usually located in Eastern and Southeastern Europe). The well-established central banks produce more research papers per author, publish a higher proportion of these papers in scientific journals, and generally achieve a higher average impact factor. On the other hand, they employ fewer female researchers. Furthermore, the vast

majority of central banks in our sample have a separate research department, but only a minority distinguish between financial and economic research in their organizational structure. Central banks are also dedicating increasingly more resources to communicating and enhancing the visibility of their research. They have become more active on social media and exploited the potential of additional forms of presentation and popularization, such as research blogs, bulletins, and newsletters. However, the use of social media for research popularization is more common among the U.S. Federal Reserve Banks and larger central banks in Europe with a well-established research tradition.

Taken as a whole, we have identified seven stylized facts of central banks' research. First, financial stability has emerged as the leading topic after the GFC. Based on a word cloud of keywords and abstracts, we find that monetary policy and macroeconomic topics in general dominated before the GFC, while the macro-finance area has taken over since then.

Second, research in central banks is becoming increasingly collaborative. While the number of publications per author per central bank is decreasing steadily over time, the number of authors per publication is on the rise. The most striking is the drop in share of the publications with a single author, from 40 percent in 2000 to less than 20 percent in 2019. The share of publications with exactly three authors, on the other hand, has more than doubled in the last two decades, reaching 30 percent in 2019. Four- or five-member teams are also becoming more common. Partly as a result of the increasingly collaborative environment, the number of papers published in central banks' series has more than doubled over the two decades.

Third, central banks form enormous research networks. The closer collaboration among researchers reflects more intensive cooperation both inside and outside the network of central banks. In other words, the increasing number of authors per central bank publication is due to both a larger number of researchers affiliated with a central bank and a larger number of those affiliated with an institution other than a central bank. Still, we find that most of the research collaboration is region specific, meaning that a central bank is more likely to collaborate with a research institution from its own country or region. Further, our data suggest that researchers tend to

leave national central banks to relocate to supranational institutions, identifying a potential problem associated with human capital flight.

The second and third stylized facts are consistent with the general tendencies in economic research identified by numerous studies over the last couple of years (see, for example, Card and DellaVigna 2013; Hamermesh 2013; Kuld and O'Hagan 2018; Essers, Grigoli, and Pugacheva 2020). They may to a large extent reflect the increasing scale and complexity of central banks' duties, as well as increasing integration, especially among European countries, and increasing interconnectedness of world economies and financial systems. Surprisingly, the increased collaboration with academia has not been reflected in an increased share of central banks' papers published in academic journals. This share stands at nearly 40 percent over the two decades, abstracting from publishing delay.

Fourth, a relatively small share of authors contributes to a relatively large number of central banks' research papers. Specifically, the top 10 percent of authors contributed to about 50 percent of all central banks' publications. This finding suggests (albeit very indirectly) that even central banks may be prone to the "extinction effect" that has been found to be present in academic research (Azoulay, Graff Zivin, and Wang 2010). Specifically, the departure of a leading researcher may result in a decrease in the central bank's publications activity.

Fifth, the share of female researchers increases over time, but the gender gap persists. The proportion of female authors in our sample rises from about 19 percent in 2000 to 25 percent in 2019. This trend is driven by an increasing share of mixed research teams (involving both women and men), while the share of all-women research teams remains stable over time. Further, small central banks engage more female researchers than larger central banks. A similar pattern was observed by Auriol, Friebel, and Wilhelm (2020), who showed that the more prestigious the research institution is, the fewer female economists are present. As for the relative comparison with other R&D sectors, central banks stand somewhere between the business enterprise sector and the government and higher education sectors.

Sixth, larger, well-established central banks with a long research tradition achieve a higher impact factor of their in-house research publication series as well as their papers published in scientific journals. Although we cannot say that central banks' publications with a

higher impact factor have higher policy relevance, the impact factor can be an important measure of "value for research." Central banks' publication series that enjoy a higher impact factor serve as a fundamental source of inspiration to other researchers, and as such may have a significant impact on the direction of future research. Nevertheless, the impact factor should be interpreted cautiously, because the overall impact factor—by design—can be boosted by a small number of papers with a high number of citations.

Seventh, a relatively small proportion of central banks' research papers published in scientific journals contribute the most to the average and median impact factor. This indicates that the pattern described in the previous paragraph may also apply to the impact factor of central banks' in-house publication series. This may be true because there is a high positive correlation between the impact factor assigned to central banks' in-house publication series and the average impact factor of the papers published in a scientific journal.

Appendix A. Data

Table A.1. Items Included in the Research Scores

Item	Question	ORS	ROS	RPuS	RPoS
A	Is there a separate research department?	Y	Y	N	N
B	Is financial research separated in the CB's organizational structure?	Y	Y	N	N
C	Is there an associated research institution?	Y	Y	N	N
D	Is there a separate webpage (or section of a website) for research?	Y	N	N	Y
E	Is there a separate webpage (or section of a website) for financial research? (if 0.5, then financial research can be separated from other research—for example, by tags—but there is no separate webpage for it)	Y	Y	N	N
F	Are the research areas promoted on the research website? (if 0.5, then the research areas are stated only briefly)	Y	N	N	Y
G	Is there a webpage which summarizes researchers' profiles?	Y	N	N	Y
H	Is there a working paper (WP) series published by the CB?	Y	N	Y	N
I	Is there a discussion paper (DP) series published by the CB?	Y	N	Y	N
J	Is there any other publication series except for the WP and DP series?	Y	N	Y	N
K	Does the CB publish its own research bulletin?	Y	N	N	Y
L	Is there a research blog in the CB?	Y	N	N	Y
M	Is there a research newsletter in e-mail form? (if 0.25, then the research newsletter takes the form of e-mail notifications about updates to research websites; if 0.5, then the research newsletter takes the form of an e-mail campaign)	Y	N	N	Y
N	Is there a research newsletter in pdf/document form? (if 0.5, then the research newsletter takes the form of a pdf/document)	Y	N	N	Y
O	Have there been any posts related to the research activities of the CB on LinkedIn in the last six months (as of February/March 2020)?	Y	N	N	Y
P	Have there been any posts related to the research activities of the CB on YouTube in the last six months (as of February/March 2020)?	Y	N	N	Y

(*continued*)

Table A.1. (Continued)

Item	Question	ORS	ROS	RPuS	RPoS
Q	Have there been any posts related to the research activities of the CB on Twitter in the last six months (as of February/March 2020)?	Y	N	N	Y
R	Is there a separate Twitter account for research?	Y	N	N	Y
S	Does the CB have an RePEc account?	Y	N	Y	N
T	Does the CB advertise any calls for projects on its website?	Y	N	N	Y
U	Does the CB offer any form of research cooperation?	Y	N	N	Y
V	Are there any research events organized by the CB?	Y	N	N	Y
W	Is there any webpage which lists the journal articles written by the CB's staff? (if 0.5, then journal articles written by the CB's staff can be accessed only via the researchers' profile pages)	Y	N	Y	N
X	Does the CB provide data sources for its research publications? (if 0.5, then the CB provides research data in general, but these data sets are not explicitly connected to given research publications)	Y	N	Y	N
Y	Does the CB organize any research competitions or appraisals?	Y	N	N	Y
Z	Does the CB offer any trainee/internship program connected to research?	Y	N	N	Y

Note: The full Research Score Data Set is available in the working paper version of this article (Malovaná, Hodula, and Rakovská 2020). ORS—Overall Research Score; ROS—Research Organization Score; RPuS—Research Publication Score; RPoS—Research Popularization Score.

Table A.2. Publication Series Covered in the IDEAS/RePEc Data Set

Country		Central Bank	Source	Outlet*	Period	No. of Papers	
			A. Europe				
1	IT	Banca d'Italia	IDEAS/RePEc	WP	2000–19	893	1,430
				DP	2006–19	537	
2	RO	Banca Nationala a Romaniei	Institution's Website	OP	2002–19	28	28
3	ES	Banco de España	IDEAS/RePEc	WP	2000–19	686	782
				OP	2005–19	96	
4	PT	Banco de Portugal	IDEAS/RePEc	WP	2000–19	382	382
5	MT	Bank Centrali ta' Malta	IDEAS/RePEc	WP	2013–19	33	33
6	UK	Bank of England	IDEAS/RePEc	WP	2000–19	737	832
				FSP	2006–18	44	
				MPCDP	2000–19	51	
7	GR	Bank of Greece	IDEAS/RePEc	WP	2003–19	276	276
8	AL	Banka e Shqiperise	Institution's Website	RP	2000–19	82	
9	SL	Banka Slovenije	Institution's Website	WP	2013–19	20	97
				DP	2000–19	77	
10		Banque Centrale du Luxembourg	IDEAS/RePEc	WP	2001–19	124	124
11	FR	Banque de France	IDEAS/RePEc	WP	2000–19	671	681
				OP	2006–17	10	
12	BG	Bulgarian National Bank	Institution's Website	DP	2001–19	61	61
13	CY	Central Bank of Cyprus	IDEAS/RePEc	WP	2007–19	55	55
14	IE	Central Bank of Ireland	IDEAS/RePEc	RTP	2000–19	214	214
15	CZ	Česká Národní Banka	IDEAS/RePEc	WP	2002–19	245	281
				RPN	2003–19	36	
16	DK	Danmarks Nationalbank	Institution's Website	WP	2002–19	141	141
17	NL	de Nedelandsche Bank	IDEAS/RePEc	WP	2004–19	660	660
18	DE	Deutsche Bundesbank	IDEAS/RePEc	DP	2013–19	346	834
				DP1ES	2000–11	368	
				DP2BFS	2003–11	120	

(*continued*)

Table A.2. (Continued)

Country		Central Bank	Source	Outlet*	Period	No. of Papers	
			A. Europe				
19	EE	Eesti Pank	IDEAS/RePEc	WP	2000–19	159	159
20	HR	Hrvatska Narodna Banka	IDEAS/RePEc	WP	2000–19	53	53
21	LV	Latvijas Banka	IDEAS/RePEc	WP	2001–19	75	89
				DP	2009–19	14	
22	LT	Lietuvos Bankas	IDEAS/RePEc	WP	2008–19	66	95
				DP	2016–19	16	
				OP	2016–19	13	
23	HU	Magyar Nemzeti Bank	IDEAS/RePEc	WP	2000–19	138	210
				OP	2001–19	72	
24	MK	Narodna Banka na Republika Severna Makedonija	IDEAS/RePEc	WP	2000–19	60	60
25	SK	Národná Banka Slovenska	IDEAS/RePEc	WP	2006–19	69	69
26	RS	Narodna Banka Srbije	IDEAS/RePEc	WP	2005–15	31	31
27	PL	Narodowy Bank Polski	IDEAS/RePEc	WP	2002–19	294	294
28	UA	National Bank of Ukraine	IDEAS/RePEc	WP	2016–19	9	9
29	BE	Nationale Bank van België/Banque national de Belqique	IDEAS/RePEc	WP	2000–19	334	334
30	NO	Norges Bank	IDEAS/RePEc	WP	2003–19	337	337
31	AT	Oesterreichische Nationalbank	IDEAS/RePEc	WP	2000–19	187	187
32	IS	Sedlabanki Íslands	IDEAS/RePEc	WP	2000–19	76	76
33	SW	Schweizerische Nationalbank	IDEAS/RePEc	WP	2004–19	215	215
34	FI	Suomen Pankki	IDEAS/RePEc	RDP	2000–19	597	1,064
				BOFIT	2000–19	467	
35	SE	Sveriges Riksbank	IDEAS/RePEc	WP	2000–19	279	279

(*continued*)

Table A.2. (Continued)

Country		Central Bank	Source	Outlet*	Period	No. of Papers	
B. United States							
36	Georgia	Federal Reserve Bank of Atlanta	IDEAS/RePEc	WP	2000–19	494	494
37	Massachusetts	Federal Reserve Bank of Boston	IDEAS/RePEc	WP	2000–19	310	358
				SRAWP	2007–19	48	
38	Ohio	Federal Reserve Bank of Cleveland	IDEAS/RePEc	WP	2000–19	499	499
39	Texas	Federal Reserve Bank of Dallas	IDEAS/RePEc	WP	2000–19	197	570
				GIWP	2007–19	373	
40	Illinois	Federal Reserve Bank of Chicago	IDEAS/RePEc	WP	2000–19	477	477
41	Missouri	Federal Reserve Bank of Kansas City	IDEAS/RePEc	WP	2000–19	278	278
42	Minnesota	Federal Reserve Bank of Minneapolis	IDEAS/RePEc	WP	2000–19	166	166
43	New York	Federal Reserve Bank of New York	IDEAS/RePEc	WP	2000–19	806	806
44	Pennsylvania	Federal Reserve Bank of Philadelphia	IDEAS/RePEc	WP	2000–19	657	657
45	Virginia	Federal Reserve Bank of Richmond	IDEAS/RePEc	WP	2000–19	262	262
46	California	Federal Reserve Bank of San Francisco	IDEAS/RePEc	WP	2000–19	571	571
47	Missouri	Federal Reserve Bank of St. Louis	IDEAS/RePEc	WP	2000–19	876	876
48	Washington, D.C.	Federal Reserve Board	IDEAS/RePEc	FEDS	2000–19	1,537	2,147
				IFDP	2000–19	610	

(*continued*)

Table A.2. (Continued)

Country		Central Bank	Source	Outlet*	Period	No. of Papers	
C. International Institutions							
49	—	Bank for International Settlements	IDEAS/RePEc	WP	2000–19	752	752
50	—	European Central Bank	IDEAS/RePEc	WP	2000–19	2,335	2,335
51	—	European Systemic Risk Board	IDEAS/RePEc	WP	2016–19	106	106

Note: *WP—Working Papers; DP—Discussion Papers; OP—Occasional Papers; FSP—Financial Stability Papers; MPCDP—Monetary Policy Committee Discussion Papers; RP—Research Papers; RTP—Research Technical Papers; RPN—Research and Policy Notes; DP1ES—Discussion Paper Series 1: Economic Studies; DP2BFS—Discussion Paper Series 2: Banking and Financial Studies; RDP—Research Discussion Papers; BOFIT—BOFIT Discussion Papers; SRAWP—Supervisory Research and Analysis Working Papers; GIWP—Globalization Institute Working Papers; FEDS—Finance and Economics Discussion Series; IFDP—International Finance Discussion Papers.

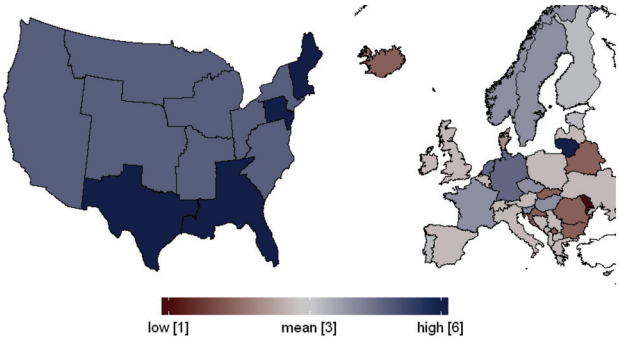
Table A.3. Central Banks in Social Media

	Social Media	EA Orig.	W & NWE	E & SEE, BC	US	ECB & BIS
CBs with Soc. Media Profile	Twitter	100%	100%	83%	100%	67%
	YouTube	91%	100%	87%	100%	67%
	LinkedIN	100%	100%	78%	100%	100%
	At Least One	100%	100%	96%	100%	100%
CBs Using Soc. Media for Research	Twitter	64%	17%	9%	85%	67%
	YouTube	45%	17%	9%	54%	67%
	LinkedIN	36%	17%	9%	69%	67%
	At Least One	64%	33%	22%	92%	67%
Avg. No. of Followers since Joining	Twitter	15.5k	300.9k	0.8k	122.3k	333.1k
	YouTube	4k	3.6k	6.5k	18.7k	29.8k
	LinkedIN	32k	196.8k	13.8k	26.9k	222.6k
Avg. No. of Years since Joining	Twitter	8	11	4	11	10
	YouTube	8	4	11	10	8
Avg. No. of Tweets since Joining	Twitter	7.1k	9k	0.4k	12.2k	14.9k
Avg. No of Views since Joining	YouTube	862.8k	608.4k	3,091.4k	496.3k	7,242.7k

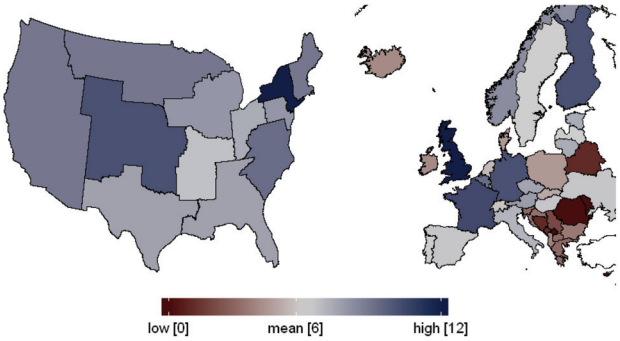
Note: The table presents a selection of intensive and extensive margin statistics on the social media usage by central banks. Social media usage data were collected from central banks' websites and social media accounts. To obtain information on the use of social media for research purposes, we analyzed posts of individual central banks over the last six months on the three most used social media platforms—YouTube, Twitter, and LinkedIn. Data from separate Twitter accounts set up solely for research purposes by the Federal Reserve Board, five other central banks in the United States (Federal Reserve Banks of New York, Philadelphia, Richmond, St. Louis, and Cleveland), and two central banks in Europe (the Bank of England and the Bank of Finland) are not included. However, all eight central banks are considered to use social media for research purposes, and these statistics reflect the situation on their general social media network profiles in order to achieve cross-sample comparability. All the statistics except for the average number of followers on LinkedIn employ the data that refer to the period of March 2020. The LinkedIn statistic refers to the period of the article's revision—February 2022. Only central banks that were identified as using social media for research purposes are considered (the list of such central banks can be found in the working paper version of this article (Malovaná, Hodula, and Rakovská 2020).

Appendix B. Additional Figures

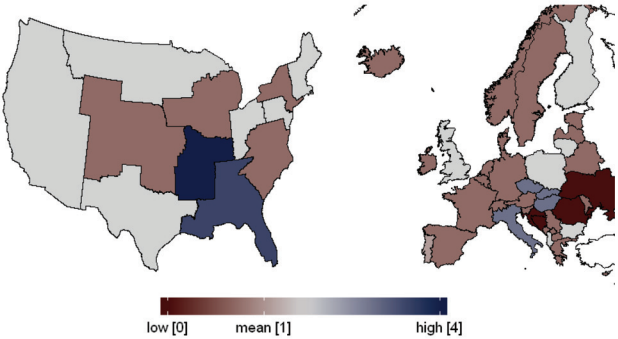
Figure B.1. Research Score Groups



A. Research Publications Score



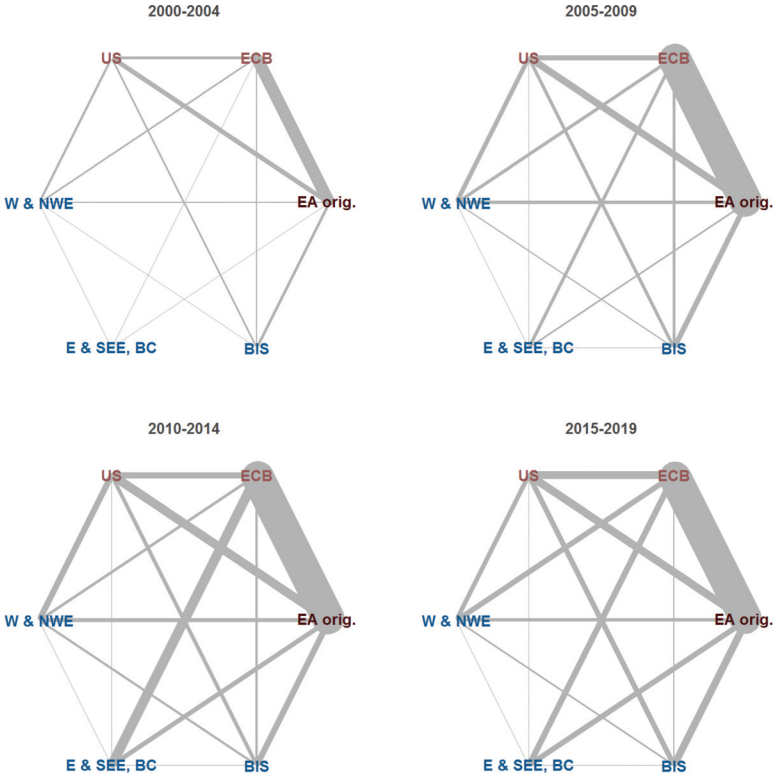
B. Research Popularization Score



C. Research Organization Score

Note: The detailed data behind the scores can be found in the working paper version of this article (Malovaná, Hodula, and Rakovská 2020) and in Table A.1. The choropleth maps do not reflect the scores for the Federal Reserve Board (FRB), the European Central Bank (ECB, including the ESRB), and the Bank for International Settlements (BIS).

Figure B.2. Authorship Networks Between Central Banks—Regionally



Note: Based on authors' self-reported affiliation in IDEAS/RePEc. The edge width indicates the relative frequency of authorships between the listed central banks (i.e., the number of publications in the given time period). Central banks shown in red account for 80 percent of publications (dark red for 50 percent and light red for the additional 30 percent).

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