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**Are Central Banks' Research Teams Fragile
Because of Groupthink?**

Jakub Rybacki

Are Central Banks' Research Teams Fragile Because of Groupthink?

Abstract

In the recent years, the great majority of central banks have globally failed to realize inflation targets. We attempt to answer a question of whether such failure resulted from insufficient organization of economic research in those institutions. Our study shows a positive, but statistically weak, relationship between these issues. However, the analysis finds also a few adverse irregularities in major central banks' research organizations. The research of the European Central Bank, Bundesbank, and the Bank of England are relatively less diversified compared to the U.S. Federal Reserve. In the cases of Poland and Italy, economic departments are dominated by groups of researchers focused on narrow topics. On the other hand, the organization of research departments in France and Canada support a greater variety of topics and independence of researchers.

Keywords: groupthink, network analysis, central banks, big data

JEL classification codes: E58, D02, I23

¹SGH Warsaw School of Economics - Collegium of Economic Analysis, e-mail: jr70663@sgh.waw.pl

1. Introduction

During the recent decade, central banks faced multiple problems with meeting their inflation targets. Furthermore, there was a strong heterogeneity between the countries, e.g., the European Central Bank (ECB) has been undershooting the 2% level of the Harmonized index of Consumer Prices (HICP) inflation for a few consecutive years. At the same time, the Bank of England has kept the country's Consumer Price Index (CPI) above this target, frequently reaching or even overshooting its target's upper boundary of 3%. The aim of this paper is to verify whether the organization of economic research departments in central banks played an important role in the decision-making process.

Institutional organizations can influence preparing economic forecasts. The subject literature reports a phenomenon of strategic forecasting (Tillmann, 2011; Ellis & Liu, 2016), where non-voting Federal Open Market Committee (FOMC) members frequently tried to influence the decisions of other policymakers by releasing overly pessimistic or optimistic estimates of inflation. The economic forecasts generated by the staff are believed to be free of this issue—the literature suggests it adds value to the policymakers' decisions (Romer & Romer, 2008). Still, we can imagine that the narratives of leading economists may influence a final decision. Therefore, it should be important for central banks to maintain researchers with diversified views and opinions in order to avoid one-sided forecasts.

We performed a network analysis of a working papers series published by leading central banks' research departments in the years 2014–2019. A full list of the analyzed institutions is presented in Table 1. The researchers publishing in the central banks' working papers series were classified into clusters based on the VOS (visualization of similarities) algorithm. Based on those clusters, we computed using the Herfindahl-Hirschman Index, describing a concentration of converging ideas.

We found a positive, but statistically weak, relationship between a low concentration of ideas in research departments and low deviations of inflation from central banks' targets. Our analysis also found some significant irregularities in major central banks' research organizations. The research of the European Central Bank, Bundesbank, and the Bank of England are relatively less diversified compared to the U.S. Federal Reserve. In the cases of Poland and Italy, economic departments are dominated by narrow groups of researchers focused on specific topics. On the other hand, the organization of research departments in France and Canada support a greater variety of topics and independence of researchers. We

define independence as a lack of co-authorship of works between scholars' groups, as those interactions may influence their view on the optimal monetary policy.

This paper is structured as follows: section 2 reviews the literature regarding the problem of research integrity in macroeconomics and potential obstacles in conducting monetary policy, section 3 presents the methodology of our research, section 4 discusses the constructed database, and section 5 reviews the obtained results. Finally, section 6 concludes the paper.

2. Literature Review

This section describes the literature on the issues related to problems of economic research integrity in the process of monetary policy decision-making. The subject of research credibility has been frequently evaluated in the context of grant financing, the peer review publication process, or dishonest behavior of authors (e.g., Ioannidis & Doucouliagos, 2013; Oswald, 2007). However, the literature on central banking is less rich.

The first problem related to research integrity is the so-called *diverse bias*. Both of the central banks' researchers and academic scholars are motivated to exaggerate both the significance and impact of tested variables and effects of recommended policy, just to justify their position. This problem is not limited only to monetary policy recommendations—economic publications in the academic journals exhibit some of the highest ratios of positively verified hypotheses across all fields of science (Fanelli, 2010). The existence of the problem was confirmed in the experimental economics studies; replications of conducted trials frequently revealed much weaker effects than initially reported in the first publication (Angrist & Pischke, 2010; Ioannidis & Doucouliagos, 2013; Maniadis et al., 2017).

Second, research staff may face a problem of *confirmation bias* (e.g., Silvia, 2012). The staff may achieve greater rewards for conformism, e.g., supporting a governor's views based on selective analysis of data rather than opposing his/her conclusion.

Third, policy recommendations are not published in a vacuum. Research shows that there is a strong polarization of conclusions amongst the economists depending on political views (Horowitz & Hughes, 2018). Furthermore, there is evidence of grouping people with similar beliefs inside the institutions. For example, Beyer and Pühringer (2019) highlight a strong consensus on anti-Trump free trade policies in the top U.S. universities or austerity packages during the Eurozone Sovereign Debt Crisis amongst scholars from the University of Bocconi in Italy. Such situations often lead to the problem of groupthink, i.e., overconfidence

in pursued recommendations, wrong assessment of its risk, and censorship of dissenters in extreme cases. Beyer and Pühringer mention that monetary and international trade policies are the branch of economics most fragile to such a phenomenon.

The existence of the groupthink problem is confirmed by an experiment conducted by Javdani and Chang (2019). The authors show that academics are more likely to agree with statements presented by a mainstream economist rather than dissenters.

Some central bank authorities are aware of this phenomenon. The Bank of England's chief economist Andy Haldane (2018) distinguishes four potential problems. The first, *preference biases*, are related to different expectations regarding the optimal conduct of monetary policy between decision-makers and the rest of society. For example, the problem may arise during a stress period, when monetary authorities can overreact in order not to be blamed of inactivity, regardless of the distributional effects of their decisions on those with the lowest income.

Second, *myopia biases* correspond to focusing on current issues and over-optimism about future events. The most recent example of a policy error is the Fed's behavior during the great moderation.

Third, *hubris biases* describe the problem related to over-confidence of monetary authorities. The research on governance (e.g., Goel & Thakor, 2008) highlights the propensity of individuals in top positions (CEOs, Prime Ministers) to accept greater risk, ignoring the advice of their chief experts. However, there is limited evidence suggesting they have better abilities compared to the research staff.

Finally, *groupthink biases* are related to confirmation of shared views and censorship of dissenting opinions. Theoretically, monetary committees are built in such manner to prevent the phenomenon. For example, candidates are selected from different academic or professional environments. However, even those safeguards can be insufficient in the wake of poor institutional performance.

Andy Haldane (2018) highlights the few organizational problems in research which may have adverse effects. First of all, economic staff members are expected to find arguments supporting executives' policy lines rather than to challenge them. Moreover, forecasts produced by central bank researchers have their biases, sometimes one-sided, and serially correlated ones.

This paper is focused on the aspects of groupthink. Our aim is to measure the diversity of research ideas produced by central banks' research. We aim to identify in which banks the concentration of ideas is unnaturally strong, based on graphs describing the network between staff researchers.

3. Methodology

This section presents the methodology of our research. Our aim is to verify whether the similarity of views presented by central banks' staff analysts have an adverse effect on the realization of inflation target strategy.

The first step of our approach is to use the VOS (Visualization of Similarities) algorithm (Van Eck et al., 2010) to classify authors of central banks' working papers into clusters. The number of clusters is set independently by technique, based on unsupervised learning.

The algorithm operates on a graph connecting authors publishing in the research department. A sample graph is presented in Figure 1.

Figure 1: Research Network of the Bank of France: An Example of a VOS Graph

Notes: A bigger bubble denotes a greater number of research manuscripts.

Each author is represented by a single node in the graph (colored bubbles). The algorithm attributes weights to every node describing the importance of following an author in the research, calculating a number of published manuscripts. Therefore, bubbles on the figures have different sizes. We will not directly refer to those weights in our calculations. The graph's edges (connections between bubbles) represent co-authorship between researchers. Each edge can also have a weight based on the number of co-occurrences of mutual publications between two authors. A bolder width of an edge on the figure denotes a greater number of mutual publications. Each node is classified to a cluster, and the clusters are represented on the figures by different colors between groups of nodes.

We applied the VOS method to measure the network connections between authors of central banks' working paper series. The idea of VOS is to create a two-dimensional mapping by minimizing a weighted sum of the squared distances between all pairs of nodes in the graph (representing authors of publications). The smaller distance between two nodes denotes the stronger connection between them.

Let n denote the number of authors in the graph, and i and j denote the indices describing two nodes. Both i and j take values from $1, \dots, n$.

s_{ij} denotes the weight of the edge between nodes i and j , which is interpreted as a similarity. The definition of calculating this ratio is presented below in the description of Equation 2.

x_i is a position of i -th node in the two-dimensional space. The algorithm will calculate values of both x and y coordinates based on information about co-authorship of publications. Both positions are assigned by the function $V(.)$.

$V(.)$ is a function measuring distance between all the graph nodes. The algorithm objective is to minimize its value. To avoid the solution where all nodes have the same location, the constraint is imposed—the average distance between two items must be equal to one. The mentioned optimization can be described by the following equations:

$$\begin{aligned} V(x_1, \dots, x_n) &= \sum_{i < j} s_{i,j} * \|x_i - x_j\|^2 \\ \text{subject to: } &\frac{2}{n * (n - 1)} \sum \|x_i - x_j\| = 1 \end{aligned} \tag{1}$$

where $\|x_i - x_j\|$ measures the distance between i -th and j -th graph node and is calculated as a Euclidian norm. Similarity, known also as association strength, is defined by the following equation:

$$s_{i,j} = \frac{k_{i,j}}{k_i * k_j} \quad (2)$$

where numerator ($k_{i,j}$) is weight of the edge between nodes describing i -th and j -th authors, defined as the observed number of co-authorships of those two authors in the publications. The denominator presents the sum of all weights of the edges corresponding to i -th author (k_i) multiplied by the sum of all weights of the edges corresponding to j -th author (k_j). The rationale of such a ratio is presented in the publication of Van Eck and Waltman (2009).

Second, the VOS algorithm assigns all nodes (authors) to the clusters, based on maximization of another function.

Let us define c_i as the number of clusters to which node i of the graph is assigned.

Function $\delta(c_i, c_j)$ takes the value of 1 if two nodes belong to the same cluster ($c_i = c_j$) and 0 in other cases.

$Z(\cdot)$ is a function classifying nodes to the clusters. Its arguments are values of c_i for all graph nodes. The algorithm objective is to maximize the following formula:

$$Z(c_1, \dots, c_n) = \sum_{i < j} \delta(c_i, c_j) * (s_{ij} - \gamma) \quad (3)$$

where s_{ij} is similarity as defined earlier in equation (2) and γ is a resolution factor. The bigger resolution factor results in a greater number of clusters. We used the default value of the resolution factor provided by the VOS viewer software (1.0) in the case of each central bank's working paper series. For more information, see Van Eck and Waltman (2014).

Next, we calculate two versions of the Herfindahl-Hirschman Index (HHI), measuring the concentration of the researchers. In the first version, we will calculate shares of authors participating in the cluster, selected by the VOS algorithm in the overall population of researchers participating in the central banks' working paper series. The final index is a sum of those shares. The HHI index formula is presented in equation (4).

$$HHI_1 = \sum_i^k sh_{i,authors}^2 \quad (4)$$

where sh_i denotes the share of authors belonging to i -th clusters in the authors' population, and k is a number of clusters.

The mathematical construction of the second index is similar. However, this time we will change the definition of share. Instead of summing up the headcount of authors classified to the cluster, we will count the number of publications published by those authors. This sum will be divided by the overall amount of manuscripts in the working paper series. Please note that, in this case, we are counting multiple times the manuscripts that have a few co-authors (e.g., publications with three authors will add three to the sum, whereas a manuscript with a single author will only add one).

This measure reflects better the heterogeneity between the importance of authors participating in the central banks' research departments. Those authors, who publish more frequently and are more interconnected with others, will increase the HHI index stronger compared to the cases when only the authors' headcount is computed.

$$HHI_2 = \sum_i^n sh_{i,publications}^2 \quad (5)$$

Our first aim is to analyze whether there exist significant deviations between central banks in the values of both HHI indices. We also attempt to report irregularities and analyze research networks of institutions perceived to be outliers.

This part of the study will be focused on the relationship between the HHI index, number of clusters, and number of researchers employed by the institution. An intuitively greater number of scholars should result in a bigger variety of topics (increasing number of clusters) and a lower concentration. We attempt to verify those hypotheses based on the simple regression models.

Our ultimate aim is to verify whether an increased concentration has an adverse effect on the realization of inflation target strategy. To verify this hypothesis, we calculate the sum of the monthly ex-post Root-Mean Square Errors (RMSE) describing the size of deviations of the inflation index (e.g., CPI) from the central banks' inflation target during the last five years (between August 2014 and August 2019). The formula is presented in equation 6.

$$Sum\ of\ deviations = \sum_t^n \sqrt{(\pi_t - \overline{\pi_t})^2} \quad (6)$$

The listing of the central banks' inflation targets is presented in Table 2. We calculate differences between realized inflation and the mid-point of the central banks' target. Inflation targets in some countries defines also the range of fluctuations (e.g., +/- 1% percentage point from mid-point); however, we do not include such an element in our analysis.

Second, we attempt to measure if a lower concentration supports realization of the mandate. The final equation is relatively straightforward; we propose a linear regression to explain deviations of inflation from the target:

$$Sum\ of\ deviations = \beta_0 + \beta_1 * HHI \quad (7)$$

We deliberately do not consider other macroeconomic variables in the formula, as the central banks' mission to maintain price stability is not conditional on those variables. We also assume that even if the central bank is not capable of directly responding to some inflationary shocks (e.g., related to food supply or disruption in the energy sector) via the traditional interest rate channel, it can establish some form of cooperation with other institutions, or direct public attention to tackle the problem.

4. Database

This section summarizes the data used throughout the research. The analysis was done on central banks' working papers series indexed in the St. Louis Fed RePeC database. For each paper published from January 2014 to September 2019, RIS (Research Information Systems) metadata was downloaded. Amongst that information, manuscripts with JEL codes describing monetary policy were selected (E5, E50, E42, E52, E58, and E59). The description of those codes is presented in Table 3.

The sample of central banks is diversified, both regarding geographical areas and the developed/emerging economies. The full listing is provided in Table 1. The biggest working paper series is the FEDS (Finances and Economy Discussion Series) provided by the Governing Board of U.S. Federal Reserve. We also separately included publications from more active regional branches from New York, San Francisco, Philadelphia, Chicago, St. Louis, and Atlanta. The branches from Dallas, Richmond, Boston, Minneapolis, and Kansas City were not included, as the number of publications provided by these branches is relatively low.

There is also a strong eurozone coverage. We included working paper series from the ECB, Bundesbank, DNB (Netherlands), and the central banks of France, Italy, Spain, Portugal, and Belgium. The research papers from the Austrian, Greek, and Baltic countries' central banks were omitted due to their low publishing activity. From Europe, we also include central banks from Scandinavian economies (Sweden and Norway), emerging CEE states (Poland, the Czech Republic, and Hungary), and the United Kingdom. Finally, the group of non-European developed economies also includes Canada, Japan, Australia, and New Zealand.

The single drawback is related to a lower coverage of emerging markets outside of Europe. In the regions of the Americas and Asia-Pacific, we only included the Bank of Mexico. Major central banks in Asia (e.g., in Malaysia, India, or Indonesia) rarely present research papers. Similarly, the economic research in the CIS space is also developing, e.g., the working papers of the Bank of Russia are presented from 2015 only. South American major central banks (e.g., Brazil and Chile) often publish in their national languages or do not provide JEL codes for their publications.

5. Estimation Results

This chapter summarizes the findings of our research. First, we attempt to measure the characteristics of concentration of research ideas and identify those banks that can be classified as outliers, i.e., having a significantly greater or lower concentration compared to others. Second, we attempt to check whether a greater emphasis on studies regarding monetary policy indeed helps to realize inflation target strategy.

Our hypothesis states that an increase of employed people in the economic research field should support greater variety of topics and a lower concentration of co-authorships. Figure 2 presents the relationship between the number of researchers employed by the institution and the number of clusters derived by a VOS algorithm. Figure 3 plots the relationship between the number of authors and derived HHI index. Our hypothesis was confirmed by a regression analysis.

There are also a few outliers in both equations that are worth further comments. First of all, the number of clusters present for the case of the European Central Bank (ECB), the Bank of England, and Bundesbank fell short compared to the U.S. Federal Reserve, taking into account the number of employed staff. This result remains robust regardless of the form of the model (e.g., linear, exponential, with power). A more diversified research environment is present in the cases of the Bank of France (FR), Bank of Canada (BoC), and Bank of Finland

(FI). Visualizations of the mentioned central banks' research networks are presented in Appendix 1.

Figure 2: The Relationship Between Number of Clusters and Number of Authors

Notes: Acronyms used in the chart are explained in Table 4. The underlying data is presented in Table 5.

The study of the first HHI concentration index (counting headcounts of the authors and omitting information about the number of publications per author) confirms the following findings. The index calculated for the Bank of France (37.89) has a similar value compared to the institutions employing a greater number of economists (e.g., Bundesbank, Bank of England, respectively, at 46.11 and 42.74) and only slightly higher than for the U.S. Federal Reserve's Working Paper Series (24.94). The outperformance is visible also in the case of the Bank of Finland. The Bank of Spain presents the biggest deviation from the hyperbolic relationship and is visible in Figure 3; the concentration in this institution is bigger compared to the theoretical value.

Figure 3: The Relationship Between Number of Authors and Concentration

Notes: Acronyms used in the chart are explained in Table 4. The underlying data is presented in Table 5.

Second, we compared the results of the second HHI Index, measuring the share of publications submitted by the authors to the central banks' working paper series. Under such an approach, the index value for ECBs does not deviate from the theoretical value. A similar situation occurs in the cases of the other large banks (e.g., Bundesbank, Bank of England).

On the other hand, there are two national banks where the concentration is much stronger than the theoretical values. These are the National Bank of Poland (NBP) and the Bank of Italy (IT). Both banks were not reported as outliers in the first exercise, when the headcount of the authors played a major role. A strong difference between the two HHI indices denotes that a group of researchers in those institutions (NBP, IT) are publishing much more research compared to other colleagues. The consequence of this problem may be related to a greater influence of analysis from one source on the final decision. This situation is also unmanageable in the context of human resources—random accidents may influence the research performance.

This problem is also visible in the cases of the regional Fed branches, e.g., in San Francisco (Fed CA), Philadelphia (Fed PA), or Atlanta (Fed GA). However, its importance in the case of the United States is lower, as the authors of these institutions can also publish in the Board of Governors' working paper series, the Finance and Economics Discussion Series (FEDS). Again, the organization of economic research in France and Canada seems to result

in a lower co-occurrence of authorship between the authors. The relationship is presented in Figure 4.

Figure 4: The Relationship Between Number of Publications and Concentration

Notes: Acronyms used in the chart are explained in Table 4. The underlying data is presented in Table 5.

To present a more user-friendly approach, we computed the differences between the HHI index based on the number of authors and a similar index based on the number of publications. The results are presented in Figure 5. The Italian and Polish central banks achieved the largest discrepancy between HHI_1 and HHI_2 . Amongst national banks, the discrepancy is elevated also in the case of Japan (BoJ) and Mexico (Banxico).

Figure 5: Discrepancy Between Two HHI Concentration Indicators

Notes: Acronyms used in the chart are explained in Table 4. The underlying data is presented in Table 5.

Finally, we attempt to identify a relationship between the concentration in the economic research and deviations of the targeted inflation index from the central banks' goals, measured by the 5-year RMSE. The number of central banks available in our sample is relatively low

(14) because banks in the Eurozone and the regional Fed branches do not carry independent monetary policies. The result of the simple OLS regression is presented in Figure 6.

Figure 6: Research Concentration and Realization of Inflation Target

Notes: Acronyms used in the chart are explained in Table 4. The underlying data is presented in Table 6.

We found a positive relationship between the organization of research and the deviations of inflation from the target. The conclusions based on the equation are not statistically strong. The present sample is very small, and the statistical significance of the Beta parameter is only weak because the t-statistic is equal to 2.26 and the respective p-value is slightly higher than 0.05. Unfortunately, at the present moment, it is hard to provide a better dataset. The working paper series of the central banks were much less developed prior to 2014. Institutions in emerging markets are still in progress in building their research capacity.

6. Policy Conclusions

Our analysis shows weak evidence that the organization of economic research supporting a diversified and independent environment improves the realization of central banks' targets. The presented relationships between the number of authors and concentration measured by HHI indices suggest benefits from expanding a network above 50 authors. Amongst selected the countries, a greater diversification would be beneficial in the cases of the CEE states (Poland, Czech Republic, Hungary) and Mexico. It is also worth to engage in activities supporting international cooperation. For example, visiting research programs and PhD traineeships may improve the banks' performances at a relatively low cost. A good solutions for the laggards is also to contact the authorities of outperforming banks in order to establish good case practices.

The desired outcome is to improve transparency of the research work. Andy Haldane (2018) suggested that external research on central banks' forecast errors should improve their long-term performance and credibility. So far, the majority of the central banks do not publish fan charts in a user-friendly version. The glorious exceptions are the Scandinavian banks (Norges Bank and Sverige Riskbank). Even in the developed economies, there is a strong area for improvement in the case of standards for data dissemination related to published analytical notes.

Finally, some improvement in organization may also result from more frequent feedback from the stakeholders, e.g., staff, media sector, and academic and commercial analysts.

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Table 1: List of Analyzed Central Banks

Europe	Asia and America
European Central Bank	U.S. Federal Reserve
Bundesbank	U.S. Atlanta Fed
Bank of France	U.S. Chicago Fed
Bank of Italy	U.S. New York Fed
Bank of Spain	U.S. St. Louis Fed
Bank of Belgium	U.S. San Francisco Fed
Bank of Finland	Bank of Japan
De Nederlandsche Bank	Bank of Canada
Bank of England	Reserve Bank of Australia
Riksbank (Sweden)	Reserve Bank of New Zealand
Norges Bank (Norway)	Bank of Mexico
Swiss National Bank	
National Bank of Poland	
National Bank of Hungary	
Czech National Bank	

Table 2: Inflation Targeting in Analyzed Economies

Bank	Targeted index	Desired index value (2019)
European Central Bank	HICP	2%
Bank of England	CPI	2%
Riksbank	CPIF	2%
Norges Bank	CPI	2%*
Swiss National Bank	CPI	2%
National Bank of Poland	CPI	2,5% +/- 1%
National Bank of Hungary	CPI	3% +/- 1%
Czech National Bank	CPI	2% +/- 1%
U.S. Federal Reserve	PCE	2%
Bank of Japan	CPI	2%
Bank of Canada	CPI	2% +/- 1%
Reserve Bank of Australia	CPI	2-3%
Bank of Mexico	CPI	3% +/- 1%

Source: Central Bank Webpages

Notes: Norges Bank decided to lower its inflation target for CPI from 2.5% to 2% in 2018.

Table 3: Publication JEL Codes Used in the Internet Queries

JEL code	Full description
E5	Monetary Policy, Central Banking, and the Supply of Money and Credit
E50	General
E51	Money Supply • Credit • Money Multipliers
E52	Monetary Policy
E58	Central Banks and Their Policies
E59	Other

Source: American Economic Association

Table 4: Acronyms Used in the Charts

Bank	Acronym		Bank	Acronym
European Central Bank	ECB		Fed (Governing Board)	Fed
Bundesbank	DE		Fed (New York)	Fed NY
Bank of Italy	IT		Fed (San Francisco)	Fed CA
Bank of France	FR		Fed (St. Louis)	Fed MO
Bank of Spain	ES		Fed (Chicago)	Fed IL
De Nederlandsche Bank	DNB		Fed (Atlanta)	Fed GA
Bank of Finland	FI		Fed (Philadelphia)	Fed PA
Bank of Belgium	BE		Reserve Bank of New Zealand	RBNZ
Bank of England	BoE		Reserve Bank of Australia	RBA
National Bank of Poland	NBP		Bank of Canada	BoC
Czech National Bank	CNB		Bank of Japan	BoJ
National Bank of Hungary	NBH		Bank of Mexico	Banxico
Norges Bank	Norges			
Sveriges Riksbank	Riksbank			
Swiss National Bank	SNB			

Table 5a: Research Diversity Metrics in the Eurozone

Central Bank	ECB	DE	IT	FR	ES	DNB	FI	BE
Authors	318	176	66	108	83	112	62	41
Clusters	77	37	22	38	19	24	25	15
HHI (A)	25.51	41.32	63.36	37.89	75.34	52.14	55.67	76.74
Top 5 (A)	25%	32%	45%	30%	52%	35%	39%	46%
Top 10 (A)	42%	52%	70%	50%	75%	64%	63%	80%
HHI (P)	36.71	46.11	129.39	48.01	87.40	67.72	66.33	89.36
Top 5 (P)	32%	33%	61%	36%	58%	43%	42%	49%
Top 10 (P)	49%	56%	77%	58%	80%	73%	65%	81%
HHI(P) – HHI(A)	11.19	4.79	66.03	10.12	12.06	15.58	10.66	12.62

Notes: (A) denotes the metric is based on the share of authors belonging to a selected cluster in the central bank's research population. (P) denotes the metric based on publications. Top 5 describes the cumulative share of the five biggest clusters in the research, and Top 10 is for the biggest ten clusters. See Table 4 for explanations of the central banks' acronyms.

Table 5b: Research Diversity Metrics in the United States

Central Bank's branch	Governing Board	New York	San Francisco	St. Louis	Chicago	Atlanta	Philadelphia
Authors	210	86	55	48	43	30	23
Clusters	71	20	15	14	15	8	9
HHI (A)	24.94	63.28	88.26	81.60	81.67	151.11	145.56
Top 5 (A)	23%	43%	55%	50%	51%	77%	78%
Top 10 (A)	38%	71%	85%	81%	81%	100%	100%
HHI (P)	40.24	69.47	121.04	98.01	112.87	183.21	185.19
Top 5 (P)	35%	44%	50%	46%	66%	84%	61%
Top 10 (P)	51%	71%	91%	76%	87%	100%	100%
HHI(P) – HHI(A)	15.29	6.19	32.78	16.41	31.21	32.10	39.63

Notes: See explanations in Table 5a.

Table 5c: Research Diversity Metrics in Europe (Non-Eurozone Economies)

Central Bank	BoE	NBP	CNB	NBH	Norges	Riksbank	SNB
Authors	176	43	43	17	56	54	63
Clusters	36	16	13	6	19	18	18
HHI (A)	42.74	89.24	87.07	176.47	70.79	71.33	70.80
Top 5 (A)	32%	58%	53%	88%	48%	46%	48%
Top 10 (A)	56%	84%	86%	100%	77%	76%	73%
HHI (P)	49.92	133.46	96.67	179.01	86.88	82.97	83.18
Top 5 (P)	34%	68%	55%	89%	56%	49%	56%
Top 10 (P)	63%	93%	90%	100%	82%	80%	75%
HHI(P) – HHI(A)	7.18	44.23	9.59	2.54	16.09	11.64	12.38

Notes: See explanations in Table 5a.

Table 5d: Research Diversity Metrics in the Americas and Asia

Central Bank	BoC	BoJ	RBA	RBNZ	Banxico
Authors	109	48	21	9	36
Clusters	32	14	6	4	12
HHI (A)	46.04	86.81	192.74	283.95	108.02
Top 5 (A)	35%	54%	95%	100%	64%
Top 10 (A)	60%	85%	100%	100%	94%
HHI (P)	54.49	122.45	207.10	300.00	135.20
Top 5 (P)	36%	65%	96%	80%	70%
Top 10 (P)	63%	87%	100%	100%	95%
HHI(P) – HHI(A)	8.45	35.65	14.36	16.05	27.18

Notes: See explanations in Table 5a.

Table 6: The Realization of Inflation Target vs. Research Diversity

	Deviation of inflation from the central bank's target in the last 5 years (August 2019)	HHI index (based on authors)
Bank of Canada	4.56	46.04
Sveriges Riksbank	5.63	71.33
Norges Bank	6.43	70.79
U.S. Federeal Reserve	7.67	24.94
Czech National Bank	8.77	87.07
Bank of England	9.19	42.74
European Central Bank	10.17	25.51
Bank of Japan	12.09	86.81
Swiss National Bank	15.65	70.80
National Bank of Hungary	16.42	176.47
National Bank of Poland	17.93	89.24

Appendix 1: Visualization of Exceptional Central Banks' Research Networks

The Bank of France's research network is an example of good case practices. The number of independent scholars' teams is diversified. HHI indices suggest a lower concentration compared to other banks with similar levels of research staff employment. The research network is provided in Figure 7.

Figure 7: Research Network of the Bank of France

Notes: A bigger bubble denotes a greater number of research manuscripts.

Another example of a central bank with diversified research on monetary policy and no imbalances is the Bank of Canada. Its research network is presented below:

Figure 8: Research Network of the Bank of Canada

Notes: A bigger bubble denotes a greater number of research manuscripts.

Finally, the Bank of Finland achieved a lower concentration compared to similar peers amongst the smaller central banks.

Figure 9: Research Network of the Bank of Finland

Notes: A bigger bubble denotes a greater number of research manuscripts.

The National Bank of Poland's research team is strongly dominated by two groups of researchers. The first, led by Marcin Kolasa and Michał Brzoza-Brzezina, is focused on DSGE modelling. The second, led by Mariusz Kapuściński, focuses on inflation expectations and monetary transmission. The number of manuscripts published outside of cooperation with these groups is very small in comparison to other banks.

Figure 10: Research Network of the National Bank of Poland

Notes: A bigger bubble denotes a greater number of research manuscripts.

A similar problem is visible in Italy. The research is dominated by Massimiliano Pisani and Alessandro Notarpietro, who intensively publish on various topics regarding monetary policy, e.g., evaluation of unconventional instruments, R&D spending, and public investments. The researchers published, respectively, 13 and 12 manuscripts in the last five years, whereas the activity of the other groups was significantly smaller; e.g., Stefano Neri published only five manuscripts.

Figure 11: Research Network of the Bank of Italy

Notes: A bigger bubble denotes a greater number of research manuscripts.

Appendix 2: Visualization of the Biggest Central Banks' Research Networks

This appendix presents the research networks of the U.S. Federal Reserve, European Central Bank, Bundesbank, and Bank of England. There are no significant imbalances in this group. The organization of U.S. research seems to be more effective in providing a diversity of covered topics.

Figure 12: Research Network of the U.S. Federal Reserve

Notes: A bigger bubble denotes a greater number of research manuscripts.

Figure 13: Research Network of the European Central Bank

Notes: A bigger bubble denotes a greater number of research manuscripts.

Figure 14: Research Network of the Bundesbank

Notes: A bigger bubble denotes a greater number of research manuscripts.

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