GOSPODARKA NARODOWA

ISSN: 0867-0005
eISSN: 2300-5238

4(304)2020, 81–103
DOI: 10.33119/GN/128216

The Polish Journal of Economics

gnpje.sgh.waw.pl

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Are Central Banks' Research Teams Fragile Because of Groupthink in the Area of Monetary Policy? – Evidence on Inflation Targeting

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

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

JEL Classification Codes: D02, E58, I23

Article submitted April 2, 2020, revision received September 21, 2020,
accepted for publication October 6, 2020

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Czy departamenty badań ekonomicznych banków centralnych są narażone na myślenie grupowe w obszarze polityki pieniężnej? – przykład realizacji celu inflacyjnego

Streszczenie: W ubiegłych latach stosunkowo duża część banków centralnych miała problem z realizacją własnych celów inflacyjnych. Badanie ma na celu odpowiedzieć, czy przyczyną tego zjawiska jest niedoskonała organizacja prac działów badań ekonomicznych. Przedstawiony model wskazuje pozytywną, choć stosunkowo mało istotną statystycznie relację pomiędzy koncentracją idei poruszanych w badaniach a sumą odchyleń od celów inflacyjnych. Przedstawione zostały również nieregularności widoczne w danych. Amerykańska Rezerwa Federalna, Bundesbank czy Bank Anglii prowadzą mniej zdywersyfikowane badania niż EBC. Departamenty badań Banku Włoch oraz NBP są zdominowane przez prace wąskiej grupy badaczy. Z kolei Banki Francji i Kanady prowadzą najbardziej różnorodne badania.

Słowa kluczowe: big data, analiza sieci, banki centralne, myślenie grupowe

Kody klasyfikacji JEL: D02, E58, I23

Artykuł złożony 2 kwietnia 2020 r., w wersji poprawionej nadesłany 21 września 2020 r., zaakceptowany 6 października 2020 r.

Introduction

The aim of this paper is to present a methodology for measuring the concentration of ideas in central bank research departments based on the network of co-authorships in working paper series publications. The application of such a methodology may help support the management of human resources in institutions such as central banks and think tanks. Based on RePEc data, we identify which organisations offer a greater variety of monetary policy ideas.

We apply that information to check whether more diversified teams are capable of lowering the deviation of inflation from a central bank's target. Greater diversity should theoretically protect the decision-making process from psychological biases. If benefits from diversification exist, concentrated research is likely to be vulnerable to the groupthink bias, i.e. taking decisions based on the opinions of a narrow group of people.

This problem is important because during the last decade, central banks have faced multiple problems meeting their primary objectives for inflation. There is no simple solution because problems vary between countries. The European Central Bank (ECB) has been undershooting the 2% level of the Harmonized Index of Consumer Prices (HICP) for several 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 literature on the subject provides strong evidence that institutional organisations and personal relationships in a group can influence economic

forecasting and decision making in a central bank. Authors report, for example, the 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 policy makers by releasing overly pessimistic or optimistic estimates of inflation. Probably the biggest problems arise in the case of herding behaviour in research departments. Economic forecasts generated by the staff are believed to be free of subjectivism. The literature suggests this improves the understanding of economic processes and influences the decisions of policy makers [Romer, Romer, 2008]. Surveys among former Monetary Policy Committee (MPC) members indicated that discussions with staff are generally more likely to alter the decisions of monetary authorities than an internal debate between policy makers [Apel et al., 2010; Apel et al., 2015].

We can imagine that the narratives of leading economists may influence monetary policy. Therefore, it should be important for central banks to maintain researchers with diversified views and opinions in order to avoid one-sided forecasts or decisions.

We performed a network analysis of a working papers series published by the research departments of leading central banks from 2014 to 2019. A full list of the analysed institutions is presented in Table 1. The researchers publishing in the central banks' working papers series were classified into clusters based on the VOS (visualisation of similarities) algorithm. Based on those clusters, we used the Herfindahl-Hirschman Index to compute 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 bank targets. Our analysis also found some significant irregularities in the major central banks' research organisations. The research of the U.S. Federal Reserve, the Bundesbank, and the Bank of England is less diversified than that of the European Central Bank. In the case of Poland and Italy, economic departments are dominated by narrow groups of researchers focused on specific topics. On the other hand, the organisation of research departments in France and Canada supports a greater variety of topics and researcher independence. We define independence as a lack of co-authorship of works between groups of scholars, as those interactions may influence their views on an optimal monetary policy.

This paper is structured as follows: section 2 reviews the literature on 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.

Literature Review

This section describes the literature on the problem 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, and dishonest behaviour of authors [e.g., Ioannidis, Doucouliagos, 2013; Oswald, 2007]. However, the literature on the subject is relatively quiet on psychology in central bank activities.

Probably the most mature studies of the decision-making process among monetary authorities have been conducted in the Bank of England. Its chief economist Andy Haldane [2018] distinguishes four potential problems.

The first problem, *preference biases*, is related to different expectations about the optimal conduct of monetary policy between decision makers and the rest of society. For example, this problem may arise during a stress period when monetary authorities can overreact in order not to be blamed for inactivity, regardless of the distributional effects of their decisions on those with the lowest income.

The second problem, *myopia biases*, involves current issues and over-optimism about future events. The most recent example of a policy error is the Fed's behaviour during the Great Moderation period.

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

Finally, *groupthink biases* are related to confirming shared views and censorship of dissenting opinions. Theoretically, monetary committees are built in such a way so as to prevent such biases. For example, candidates are selected from different academic and professional environments. However, even such safeguards can be insufficient in the face of poor institutional performance.

The biggest challenge in the relationship between decision makers and staff researchers is probably related to groupthink biases. The idea originated from psychological studies. Irving Janis [2008] analysed some of the most consequential White House decisions, including Pearl Harbor, Truman's invasion of North Korea, Kennedy's Bay of Pigs fiasco, Johnson's escalation of the Vietnam War, and Nixon's handling of the Watergate scandal. He argues that in each case decision makers strived for unanimity in such a manner that they unrealistically assessed the outcomes of their decisions and alternative courses of action.

Janis observed that decision-making bodies shared a strong sense of solidarity and a desire to maintain relationships within the group at all costs. He identified eight main symptoms of groupthink: (1) an illusion of invulnerability, (2) an illusion of morality, (3) rationalisation, (4) stereotyping, (5) self-censorship, (6) an illusion of unanimity, (7) direct pressure on dissidents, and

(8) reliance on self-appointed mindguards. Subsequent works showed more problems, e.g. group polarisation – a situation when a few individuals can influence the group to accept a greater risk or make a more extreme decision than median participants are willing to accept [e.g. Whyte, 1989; Sunstein, 1999].

It may seem that a relatively large number of researchers working at central banks should help to balance opinions. Unfortunately, this is not always the case. Research staff may also face the problem of *confirmation bias* [e.g., Silvia, 2012]. The staff may achieve greater rewards for conformity, e.g., supporting a governor's views based on a selective analysis of data rather than opposing his/her conclusions. Professional promotion and academic prestige are strongly dependent on the opinions of directors and reviewers – some authors even describe this as ideological prostitution [Frey, 2003]. Concentrated research is more likely to be dependent on a narrow group of directors. This may actually turn researchers into mindguards for poorly designed policies.

There is also the well-known *diverse bias*. To justify their position, central bank researchers are motivated to exaggerate both the significance and impact of tested variables and the effects of recommended policies. This problem is not limited to monetary policy recommendations – economic publications in 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 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]. Such a bias evidently supports group polarisation. Researchers who are more determined to promote their research may achieve a greater influence on decision making due to action taken rather than the significance of their conclusions.

The literature also highlights the problem of hierarchy. For example, Javdani and Chang [2019] show that academics (many central bankers are academics at the same time) are more likely to agree with a statement attributed to a recognised mainstream economist rather than some less well-known researcher even if the statement is obviously false. Reliance on authorities helps rationalise wrong behaviour and gives an illusion of morality.

Finally, policy recommendations are not published in a vacuum. Research shows that there is a strong polarisation of conclusions among economists depending on political views [Horowitz, Hughes, 2018]. Furthermore, there is evidence that institutions tend to group together people with similar beliefs. For example, Beyer and Pühringer [2019] highlight a strong consensus on anti-Trump free trade policies in top U.S. universities and austerity packages during the eurozone sovereign debt crisis among scholars from the University of Bocconi in Italy. Those authors argue that monetary and international trade policies are the branch of economics most vulnerable to such an approach. Such problems should also be visible in a concentrated research department – their researchers are more likely to originate from the same alma mater. Situations like this often lead to the problem of overconfidence in pursued

recommendations, wrong assessment of risk, and censorship of dissenters in extreme cases which are clear results of groupthink.

Andy Haldane [2018] highlights a few organisational problems in research that may have adverse effects. First of all, economic staff members are expected to find arguments supporting executive 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 measurement of relationships between researchers. Our aim is to measure the diversity of ideas produced by central bank research in the area of monetary policy. We aim to identify in which banks the concentration of ideas is unnaturally strong, based on graphs describing the network between staff researchers. Such entities are more likely to be susceptible to groupthink.

Methodology

This section presents the methodology of our research. Our aim is to verify whether a similarity of views presented by central bank staff analysts has an adverse effect on the implementation of the 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 the authors of central bank 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.

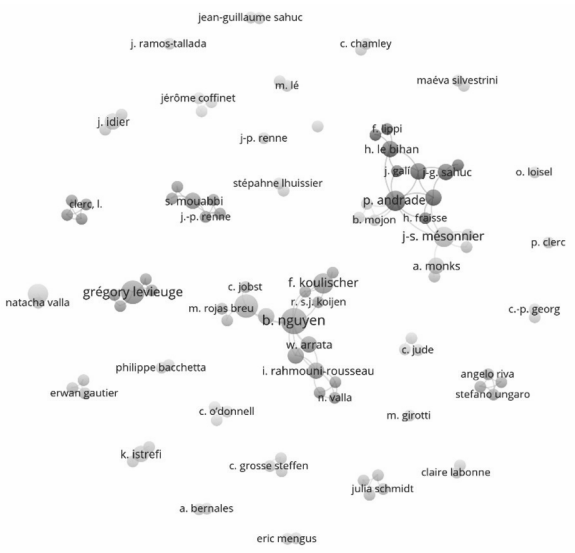
Each author is represented by a single node in the graph (coloured bubbles). The algorithm attributes weights to every node describing the importance of following an author in the research, calculating the number of published manuscripts. Therefore, the bubbles in the figure have different sizes. We 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 in the figure denotes a greater number of mutual publications. Each node is classified to a cluster, and the clusters are represented in the figure by different colours between groups of nodes.

The dataset contains information about both insiders and external authors. Although foreign researchers do not participate directly in the work of a research department, their cooperation improves the reputation of collaborating central bank employees. Domestic researchers who are recognised internationally are more likely to influence the decision.

We applied the VOS method to measure network connections between the authors of central-bank working paper series. The idea of VOS is to create a two-dimensional map by minimising the weighted sum of the squared

distances between all pairs of nodes in the graph (representing publication authors). A small distance between two nodes denotes a strong connection between them.

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



Note: A bigger bubble denotes a greater number of research manuscripts.
Source: author's own elaboration.

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…., 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 the values of both x and y coordinates based on information about co-authorship of publications. Both positions are assigned by function $V(.)$.

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

$$V(x_1, \ldots, x_n) = \sum_{i<j} s_{i,j} * \left|\left| x_i - x_j \right|\right|^2$$
$$subject\ to: \frac{2}{n*(n-1)} \sum \left|\left| x_i - x_j \right|\right| = 1 \quad (1)$$

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

$$s_{i,j} = \frac{k_{i,j}}{k_i * k_j} \tag{2}$$

where numerator ($k_{i,j}$) is the weight of the edge between the 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 the weights of the edges corresponding to *i-th* author (k_i) multiplied by the sum of all the weights of the edges corresponding to *j-th* author (k). The rationale of such a ratio is presented in the publication of Van Eck and Waltman [2009].

Second, the VOS algorithm assigns all the nodes (authors) to the clusters, based on the maximisation 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.

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

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

where s_{ij} is the similarity as defined earlier in equation (2) and γ is a resolution factor. A high resolution factor results in a large 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 the shares of the authors participating in the cluster, selected by the VOS algorithm in the overall population of researchers participating in the central-bank working paper series. The final index is the sum of those shares. The HHI index formula is presented in equation (4).

$$HHI_1 = \sum_{i}^{k} sh^2_{i,\ authors} \tag{4}$$

where sh_i denotes the share of authors belonging to i-th cluster in the authors' population, and k is the 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 into a 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 several co-authors (e.g., publications with three authors will add three to the sum, whereas a manuscript with a single author will add only one).

This measure better reflects the heterogeneity between the importance of authors participating in central bank research departments. Those authors who publish more frequently and are more interconnected with others will increase the HHI index to a greater extent than when only the authors' headcount is computed.

$$HHI_2 = \sum_{i}^{n} sh^2_{i,\ publications} \tag{5}$$

In practice, this ratio should help assess if a strong concentration is related to a shortage of staff, improper organisation of research teams, or unequal opportunities to create research between central bank scholars. In the case of a shortage of staff or the existence of teams that concentrate a greater number of researchers, both indices should be high. On the other hand, if there are teams which are more privileged to publish (e.g. have fewer responsibilities related to data maintenance and greater access to research financing) only the latter index should present the problem and the discrepancy between the indices is likely to be strong.

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

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

Our ultimate aim is to verify whether an increased concentration has an adverse effect on how the inflation target strategy is carried out. To validate 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 targets during the last five years (between August 2014 and August 2019). The formula is presented in equation 6.

$$Sum\ of\ \ deviations = \sum_{t=1}^{n} \sqrt{(\pi_t - \overline{\pi}_t)^2} \tag{6}$$

The central banks' inflation targets are listed in Table 2. We calculate the differences between actual inflation and the mid-point of the central banks'

target. Inflation targets in some countries also define the range of fluctuations (e.g., +/- 1% percentage point from the mid-point); however, we do not include such an element in our analysis.

Second, we attempt to measure if lower concentration supports the implementation of the central bank's mandate. In the case of deviations calculated in equation 6, the differences between the countries are mainly related to idiosyncratic (i.e. country-specific) shocks. The origin of those shocks is frequently related to decisions by governments or other authorities – for example to hike the minimum wage and introduce stricter environmental rules. A central bank with diversified research is more likely to respond with either policy instruments (interest rate changes or assets purchases) or indirectly, e.g. by participating in consultations and influencing the final decision in order to gradually implement inflationary changes. The BIS survey [Moser-Boehm, 2006] confirms that central bankers frequently coordinate the implementation of such policies with fiscal authorities. The scale of central bankers' influence varies between the countries and governors' terms – it is usually dependent on the personal characteristics of the governors [Adolph, 2013]. Still, these ties are becoming especially important in the era of large-scale purchases [Fernández-Albertos, 2015; De Haan, Eijffinger, 2016]. Political authorities are more tempted to pursue expansive policies given that the share of sovereign debt is backed by the central banks. Second, unconventional policies started to have distributional effects affecting welfare. The measurement of inflation deviations from the target should show whether the policy is correct.

The final equation is relatively straightforward; we propose a linear regression to explain the deviations of inflation from the target:

$$Sum\ of\ \ deviations = \beta_0 + \beta_1 * HHI + \varepsilon_t \tag{7}$$

Initially, we deliberately do not consider other macroeconomic variables in the formula as a central bank's mission to maintain price stability is not conditional on any variables. As mentioned earlier, we assume that even if a central bank is not capable of directly responding to some inflationary shocks (e.g. those related to the supply of food or disruptions 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. We will test the robustness of the results of this equation based on another set of regressions.

The proposed equation simplifies the decision-making process. The formal mandate usually describes maintaining price stability. But in reality central banks also make efforts to stabilise output gap volatility. At the moment of writing (the COVID-19 crisis), the second objective acquires a similar or maybe even greater importance. Countries where monetary authorities decided to more actively support economic growth should end up with a greater inflation increase. This increase may have a relatively small adverse social effect compared to, e.g., the risk of a labour market slack. Nevertheless, in this

author's opinion, it is worth presenting an analysis focused on inflation as this is a formal mandate. A negative perception of some central banks in such an exercise may influence policy makers to formalise the mandate in order to reflect the underlying decision-making process.

Database

This section summarises the data used throughout the research. The analysis was done on central-bank working paper 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. Among 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, in terms of both geographical areas and the developed/emerging economies distinction. The full list is provided in Table 1. The biggest working paper series is the FEDS (Finances and Economy Discussion Series) provided by the Governing Board of the 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 small.

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), CEE emerging market economies (Poland, the Czech Republic, and Hungary), and the United Kingdom. Finally, the group of non-European developed economies includes Canada, Japan, Australia, and New Zealand.

One drawback is the 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, and Indonesia) rarely present research papers. Similarly, economic research in the CIS space is developing. For example, the working papers of the Bank of Russia are only available from 2015. Major South American central banks (e.g., those in Brazil and Chile) often publish in their national languages or do not provide JEL codes for their publications.

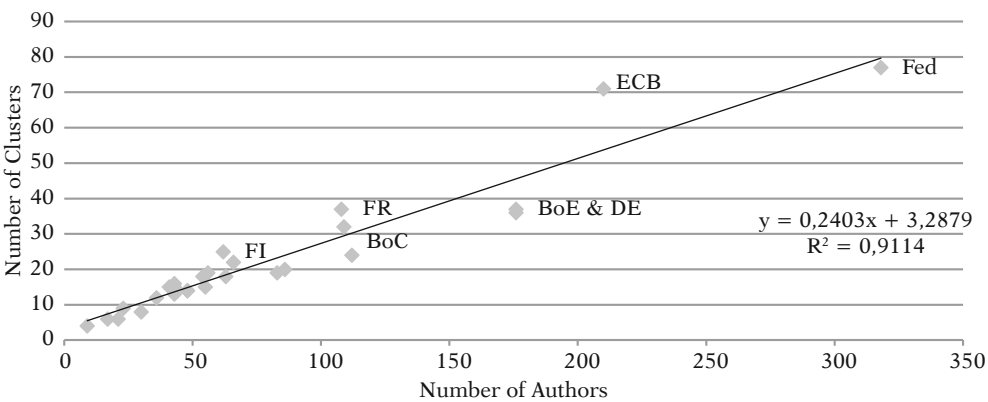
Estimation Results

This chapter summarises the findings of our research. First, we attempt to measure the characteristics of concentration of research ideas and identify banks that can be classified as outliers, i.e., those with a significantly greater or lower concentration than others. Second, we attempt to check whether a greater emphasis on monetary policy studies helps carry out the inflation targeting strategy.

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

There are also a few outliers in both equations that are worthy of further comments. First of all, the number of clusters present for the case of the U.S. Federal Reserve, the Bank of England, and the Bundesbank is proportionately lower than in the case of the European Central Bank (ECB), after taking into account the number of employed staff. This result remains robust regardless of the form of the applied model (e.g., linear, exponential, with power). A more diversified research environment is present in the case of the Bank of France (FR), the Bank of Canada (BoC), and the Bank of Finland (FI). Visualisations of the central bank research networks are presented in Appendix 1.

Figure 2. Relationship Between Number of Clusters and Number of Authors



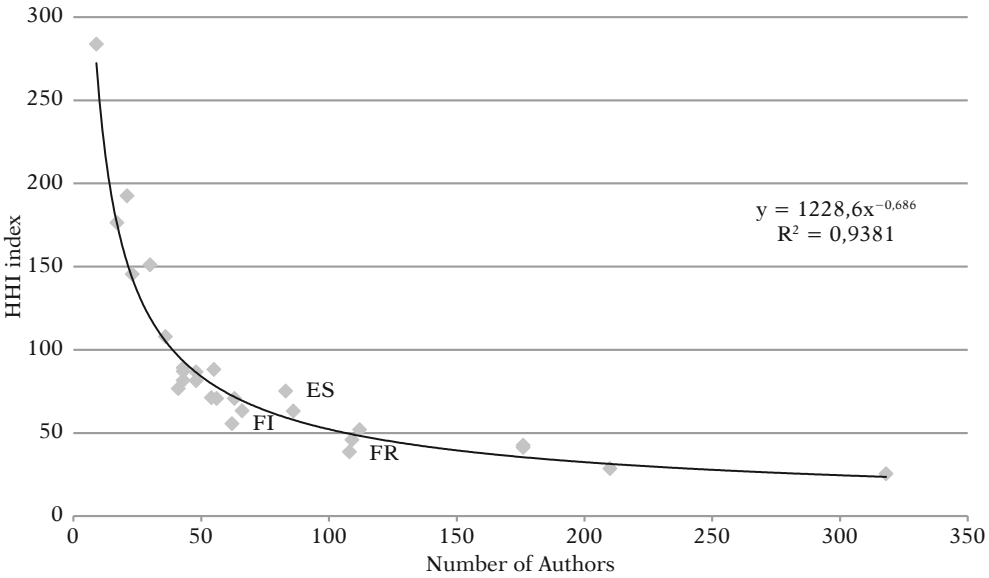
Note: Acronyms used in the chart are explained in Table 4. The underlying data is presented in Table 5.

Source: author's own elaboration.

The study of the first HHI concentration index (providing the headcount of authors and omitting information about the number of publications per

author) confirms these findings. The index calculated for the Bank of France (38.75) has a value similar to that of institutions employing a larger number of economists (e.g., Bundesbank and the Bank of England, which average at 41.32 and 42.74 respectively) and only slightly higher than the U.S. Federal Reserve's Working Paper Series (24.94). The outperformance is also visible in the case of the Bank of Finland. The Bank of Spain exhibits the biggest deviation from the hyperbolic relationship, as shown in Figure 3; the concentration in this institution is greater than the theoretical value.

Figure 3. Relationship Between Number of Authors and Concentration



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

Source: author's own elaboration.

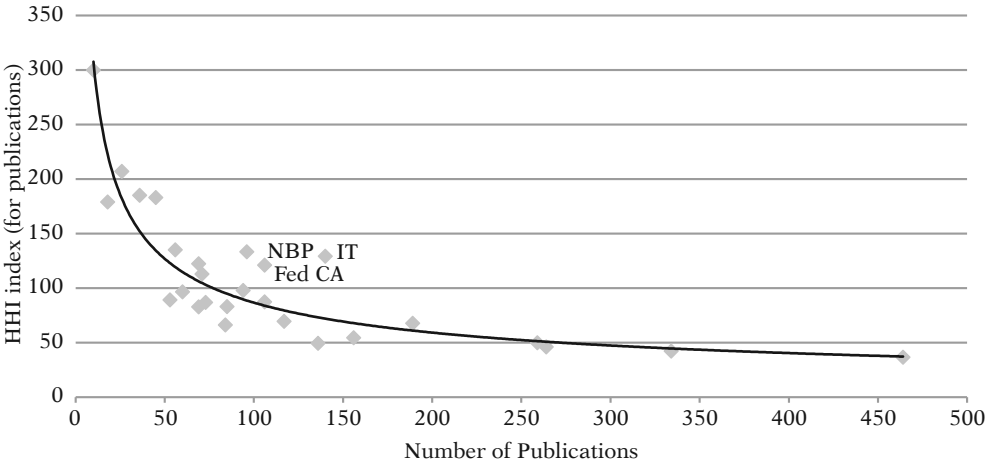
Second, we compared the results of the second HHI Index, measuring the share of publications submitted by the authors to the central banks' working paper series. Under such an approach, the index value for ECBs does not deviate from the theoretical value. A similar situation occurs in the case of other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

On the other hand, the National Bank of Poland (NBP) and the Bank of Italy (IT) exhibit concentration levels much higher than the theoretical values. These two 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 means that researchers in these two institutions publish much more research than their colleagues in other central banks. This problem stems from the greater influence of analysts from a single team. This is

undesirable in the context of human resource management. First of all, random events (e.g. traffic accidents suffered by opinion leaders) may influence research performance. Second, central bank executives should examine whether such concentration arises from unequal treatment of employees, for example a situation in which financing is only provided to selected teams.

This problem is also visible in the case of regional Fed branches, e.g., those in San Francisco (Fed CA), Philadelphia (Fed PA), and Atlanta (Fed GA). However, its importance in the case of the United States is lower as authors from these institutions can also publish in the Board of Governors' working paper series, the Finance and Economics Discussion Series (FEDS). Again, the organisation of economic research in France and Canada seems to result in a lower co-occurrence of authorship. The relationship is presented in Figure 4.

Figure 4. Relationship Between Number of Publications and Concentration



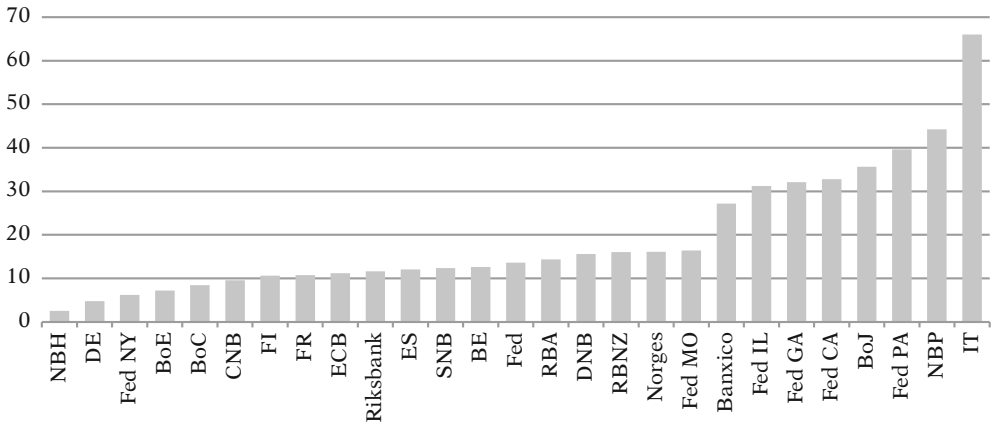
Note: Acronyms used in the chart are explained in Table 4. The underlying data is presented in Table 5.

Source: author's own elaboration.

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. Among national banks, the discrepancy is also elevated in the case of Japan (BoJ) and Mexico (Banxico).

Finally, we attempt to identify the relationship between the concentration in economic research and deviations of the targeted inflation index from the central banks' goals, measured by the five-year RMSE. The number of central banks available in our sample is relatively low (14) because banks in the eurozone and regional Fed branches do not pursue independent monetary policies. The result of the simple OLS regression is presented in Figure 6.

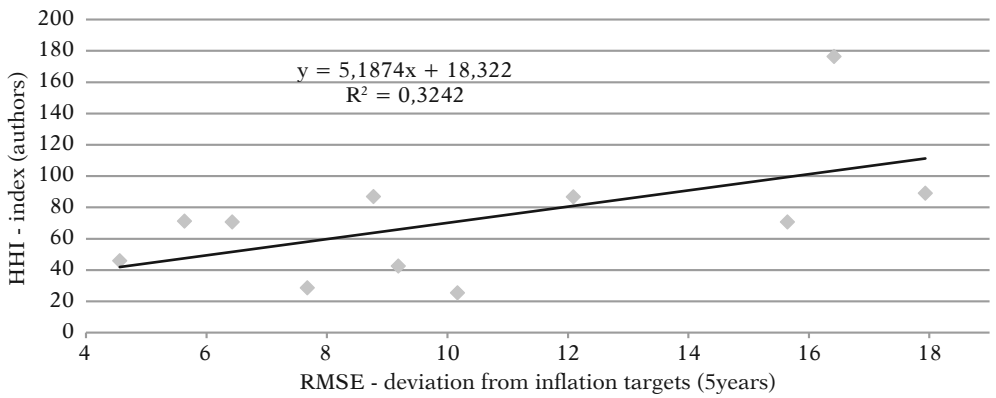
Figure 5. Discrepancy Between Two HHI Concentration Indicators



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

Source: author's own elaboration.

Figure 6. Research Concentration and Achievement of Inflation Target



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

Source: author's own elaboration.

We found a positive relationship between the organisation of research and deviations of inflation from the target. The conclusions based on the equation are not statistically strong. The sample is very small, and the statistical significance of the Beta parameter is weak because the t-statistic is equal to 2.26 and the respective p-value is slightly higher than 0.05. Unfortunately, at the 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 the process of building their research capacity.

Robustness check

Equation 7 is rather simple and straightforward. We attempt to verify if the results are robust. Multiple monetary authorities may face different structures of consumer spending. In the case of emerging markets, more volatile components such as food and energy prices constitute a greater share of expenditure (values listed in Table 7). Second, central banks may prefer to react to idiosyncratic changes with traditional policies. Therefore, discrepancies between countries may be attributed to interest rate volatility.

We proposed four models extending equation 7. In the first specification, we add a single variable reflecting the share of food and energy prices in the consumer inflation index (HICP or CPI). In the second one, we add these two variables separately. In the third model, we test whether adding interest rate volatility to the equation affects our reasoning. We calculated the standard deviation of Three-Month Interbank Offered Rates during the 2014–2019 period based on an OECD dataset. Finally, in equation 4 we added the historical volatility of the real effective exchange rate. As in the case of interbank rates, we calculated the standard deviation from the years 2014–2019, this time based on BIS data. All these equations are presented in Table 8.

The parameter corresponding to the calculated HHI Index remained stable across all specifications. This suggests that the relationship is not spurious. Parameters related to interest rate volatility and exchange rate volatility turned out to be statistically insignificant. In countries where inflation frequently missed the central bank target (for example in Poland, Switzerland and Japan), the rates were often maintained stable, while currency fluctuations did not differ significantly from those of other peers. Similarly, we do not identify statistical relationships between the inflation structure and cross-country deviations from the central bank's target.

Policy Conclusions

Our analysis provides weak evidence that the organisation of economic research supporting a diversified and independent environment improves the achievement of central bank targets. The presented relationships between the number of authors and concentration measured by HHI indices suggest that there are benefits from expanding a network above 50 authors. Among the selected countries, a greater diversification would be beneficial in the CEE states (Poland, the Czech Republic, Hungary) and Mexico.

In order to lower the concentration indices, it is also worth engaging in activities to support international cooperation. For example, visiting research programmes and Ph.D. traineeships may improve bank performance at a relatively low cost. Support from external authors for non-leading teams is likely to rebalance their position inside the research community and positively influ-

ence the HHI indices. A good solution for the laggards is also to contact the authorities of outperforming banks in order to establish best practices.

The desired outcome is to improve the transparency of research work. Andy Haldane [2018] suggested that external research on central bank 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 developed economies, there is a lot of room for improvement in standards for data dissemination related to published analytical notes.

Finally, some improvement in organisation may result from more frequent feedback from stakeholders, e.g. staff, the media sector, and academic and commercial analysts. Also, greater openness to cooperation with different entities is likely to result in a larger number of authors, more diversified ideas and lower concentration measured by the HHI indices.

Appendix

Table 1: List of analysed 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	

Source: author's own elaboration.

Table 2: Inflation targeting in analysed 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%

cont. table 2

Bank	Targeted index	Desired index value (2019)
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%

Note: Norges Bank decided to lower its inflation target for CPI from 2.5% to 2% in 2018.
Source: Central bank websites.

Table 3: Publication JEL codes used in 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		

Source: author's own elaboration.

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	37	19	24	25	15
HHI (A)	25.51	41.32	63.36	38.75	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%	51%	75%	64%	63%	80%
HHI (P)	36.71	46.11	129.39	49.52	87.40	67.72	66.33	89.36
Top 5 (P)	32%	33%	61%	38%	58%	43%	42%	49%
Top 10 (P)	49%	56%	77%	60%	80%	73%	65%	81%
HHI(P) – HHI(A)	11.19	4.79	66.03	10.12	12.06	15.58	10.66	12.62

Note: (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.
Source: author's own elaboration.

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

Note: 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

cont. table 5c

Central Bank	BoE	NBP	CNB	NBH	Norges	Riksbank	SNB
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

Note: See explanations in Table 5a.
Source: author's own elaboration.

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

Note: See explanations in Table 5a.
Source: author's own elaboration.

Table 6: Achievement 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. Federal 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

Source: author's own elaboration.

Table 7: Share of consumers' spending in the HICP/CPI basket in 2019 (%)

Country	Food & Beverages	Energy	Food & Energy
Switzerland	10.3	5.1	15.5
United Kingdom	9.9	6.3	16.2
United States	14.2	6.1	20.3
Norway	13.6	7.3	20.9
Canada	16.5	6.5	23.0
Sweden	15.7	8.7	24.4
Euro area	15.1	9.8	24.9
Czechia	18.8	12.2	31.0
Poland	18.2	13.1	31.3
Hungary	21.2	12.3	33.5
Japan	26.2	7.5	33.7

Source: Eurostat, BLS, Statistics Canada, Statistics Bureau of Japan.

Table 8: Robustness check – auxiliary regressions

Variable name	Eq 7.	Eq 7 ext 1.	Eq 7 ext 2.	Eq 7 ext 3.	Eq 7 ext 4.
Constant	5.89 (2.48, 2.37)	6.00 (5.3, 1.13)	5.76 (5.54, 1.04)	6.99 (2.74, 2.55)	14.00 (6.40, 2.19)
HHI	0.06 (0.03, 2.08)	0.06 (0.04, 1.52)	0.06 (0.04, 1.33)	0.07 (0.03, 2.28)	0.04 (0.04, 0.90)
Food & Energy		–0.01 (0.26, –0.02)			
Food			–0.15 (0.36, –0.4)		
Energy			0.33 (0.63, 0.52)		
3M rates volatility				–4.59 (4.79, –0.96)	–1.84 (5.19, –0.35)
FX REER volatility					–1.34 (1.11, –1.20)
R-Squared	0.32	0.32	0.36	0.39	0.50

Note: In each case, the deviation of inflation from the central bank's target in the last five years is set as the explanatory variable. Values corresponding to variables denote the parameter, its standard deviation and the T-statistics respectively.

Source: author's own elaboration.

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