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What Makes a Successful Scientist in a Central Bank? Evidence From the RePEc Database

Jakub Rybacki*, Dobromił Serwa†

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Abstract

This research analyzes factors affecting the scientific success of central bankers. We combine data from the RePEc and EDIRC databases, which contain information about economic publications of authors from 182 central banks. We construct a dataset containing information about 3312 authors and almost 80,000 scientific papers published between 1965 and 2020. The results from Poisson regressions of citation impact measure (called the h-index) on a number of research features suggest that economists from the U.S. Federal Reserve Banks, international financial institutions, and some eurozone central banks are cited more frequently than economists with similar characteristics from central banks located in emerging markets. Researchers from some big emerging economies like Russia or Indonesia are cited particularly infrequently by the scientific community. Beyond these outcomes, we identify a significant positive relationship between research networking and publication success. Moreover, economists cooperating with highly cited scientists also obtain a high number of citations even after controlling for the size of their research networks.

Keywords: RePEc, scientific success, h-index, big data

JEL Classification: E58, D02, I23

*Polish Economic Institute, Poland; e-mail: jakub.rybacki@pie.net.pl; ORCID: 0000-0001-7248-9536

†SGH Warsaw School of Economics, Collegium of Economic Analysis, Warsaw, Poland; e-mail: dserwa@sgh.waw.pl; ORCID: 0000-0002-1040-1815

1 Introduction

The aim of this paper is to analyze factors affecting the scientific success of economists from international central banks. The scientific success of an economist is measured in terms of the citation impact of her publications. As a measure of citation impact, we use the h-index, also known as the Hirsch index, proposed by Jorge E. Hirsch (2005). This index is defined for each author as the maximum h number of her publications that have been cited at least h times. In recent years, this index has been one of the most widely used indicators of publishing productivity and research impact.

The following arguments motivate interest in the productivity of central bank scientists. There is a wide consensus among central bankers and economists alike that monetary policy requires credibility in order to be effective (Blinder, 2000; Bordo and Siklos, 2015; Goy et al., 2020). Maintaining credibility requires proven expertise of economic knowledge. Therefore, the institutional setup of research plays an important role in policymaking. Surprisingly, bibliometric analysis of scientific research is rarely used in the context of measuring effectiveness of central bank governance and policymaking. This research may help highlight the characteristics of successful scientists, which can be used by governing bodies to develop a strong scientific basis for monetary policymaking.

Central banks also need to be accountable and transparent (Hetzel, 2012; Buiter, 2014). Central bank scientists with access to confidential data and who also interact with policymakers have a clear research advantage over external academics. Their research may help identify important economic events and reveal factors affecting decisions of policymakers that would be difficult to observe otherwise. In this way, central bank scientists provide a value added to research on monetary issues.

Finally, scientists in central banks are able to follow and understand the latest developments in economic research much more effectively than any other central bank analysts because scientists interact frequently with academics outside the banking system. These interactions, research networks, and competition with academics often lead to the introduction of advanced models and methods as new tools of monetary policy.

In this study, we measure the relationship between the author's affiliation, publishing characteristics, and her citation impact. For example, it is interesting to learn how the variety of publishing outlets affects the likelihood of a high h-index. We also investigate how the co-authorship networks are linked to publishing productivity. We obtain results based on the analysis of 182 central banks, 3312 authors, and around 80,000 scientific papers published between 1965 and 2020.

Our estimates suggest that central bankers from the U.S. Federal Reserve banks, international institutions such as Bank of International Settlements (BIS), European Central Bank, and some eurozone national banks are cited more frequently than economists with similar publishing characteristics from banks located in emerging markets. The h-indices of economists in these leading banking institutions are approximately 0.3 to 0.5 higher in comparison to the global median. There is also a

group of large emerging countries, including Russia, Indonesia, and Sri Lanka, where publishing authors perform evidently weaker than authors from advanced economies. We also identify a positive relationship between the value of h-index and the number of unique publication outlets and publishing years, but observe no additional statistically significant impact of the variety of publication topics on the publishing productivity measured with the h-index.

Finally, we detect a strong link between research networking and publishing success. The best researchers are capable of creating networks of co-authors that support their efforts. Interestingly, publishing success is positively correlated with the research network size, the share of papers written with co-authors, and the total number of authors affiliated with the same banking institution.

This document is structured as follows. Section 2 presents the literature review on the use of the h-index as a measure of citation impact. Section 3 discusses the impact of scholars on the activities of a central bank. Section 4 presents the RePEc database and its content, as well as basic statistics of constructed variables applied in our analysis. Section 5 describes the model used to measure dependence of the h-index on a number of authors' features. Section 6 summarizes the model output, and Section 7 concludes the paper.

2 Measurement of scientific success

This section presents a brief explanation of the Hirsch index (Hirsch, 2005), discusses its advantages and disadvantages, and the need for high quality publications in central banks. The h-index denotes the largest number of those papers authored by a single scientist that have been cited at least h times each. For example, an h-index equaling 3 indicates that the author published at least 3 articles and each of these articles was cited at minimum 3 times.

Frequent use of the h-index in research triggered a debate on whether it describes well the publishing productivity of specific authors. Hirsch (2007) highlights that the behavior of the h-index is rather predictable in subsequent years. The index cannot be artificially boosted by publishing a single paper in a co-authorship even if this paper is frequently cited. Opponents note that achieving a high value of this index requires frequent publishing. Ellison (2013) shows examples where distinct scholars, whose papers were cited 1000 times or more, attain relatively low h-index values just because they do not have a sufficient number of publications to increase the metrics. Jensen et al. (2009) highlight that the index does not consider the number of co-authors of a paper. A big research team may boost the h-index value by dishonest practices such as ghostwriting or extensive references to colleagues' publications. Some authors may also strategically cite those papers with the number of citations just below these authors' h-index values. Finally, another argument against this citation measure is that the average value of the h-index differs strongly between fields of economics. Nevertheless, alternative citation indices, e.g., those focusing mainly on the most

relevant author's publications, have not gained much recognition (Perry and Reny, 2016; Tol, 2009).

The versatility of the h-index has induced research that tried to determine factors supporting success in a scientific career. Acuna et al. (2012) proposed a model describing the evolution of metrics based on a scholar's characteristics, i.e., the number of published articles, and the number of years from the first publication. Bosquet and Combes (2013) focused on the number of publications and the depth of research network. Based on the analysis of g-indices amongst French economists, Bosquet and Combes claim that there exist "*increasing returns to scale*" from greater research networks and more frequent publishing. Authors publishing more studies in collaboration with other researchers achieve higher values of h-indices or g-indices. Social ties and publishing in top journals also have a strong influence on scientific careers in economics (Colussi, 2018; Heckman and Moktan, 2020). Ayaz et al. (2018) find that such factors as "average citations per paper, number of coauthors, years since publishing first article, number of publications, number of impact factor publications, and number of publications in distinct journals performed better than all other combinations" in predicting future scientific impact in the field of computer science. In our study, we use a similar set of explanatory variables to predict scientific success among economists in central banks.

3 Scholars and the central banks

This section describes the rationale of maintaining economic research in the central banks. The work of researchers is an important part of central bank communication, the latter of which has increased significantly in the last decades. Central banks started to communicate with households and corporations to shape their expectations, and to encourage saving, borrowing, consumption, investment, and other economic behavior. This instrument also helps central banks to increase their credibility (e.g., Born et al. 2014; Cieslak and Schrimpf, 2019; Haldane and McMahon, 2018; Hansen et al., 2019). The research on expertise and knowledge management in central banks has been somewhat overlooked in the literature until now, although the role of central banks is inevitable in this area (Trichet, 2008; Claveau and Dion, 2018).

The topics of scientific success and academic integrity have major relevance in central banking. For example, several papers show that metrics of scientific excellency are considered during the employment and salary negotiations of researchers (Ellison, 2013; Hilmer et al., 2015). Therefore, economists have a financial motivation to strategically approach their work.

Central bankers are especially prone to the problem known as confirmation bias (Frey, 2003; Silvia, 2012). Analysts have a greater motivation to conformism rather than opposing the wrong ideas of their direct supervisors because analysts' promotion is purely dependent on the supervisors' opinions. Another frequent but less concerning issue is that authors tend to exaggerate their findings. Some studies showed that

researchers too often present parameters whose p-values lie too close to the common thresholds of significance, i.e., 5% or 1% (Brodeur et al., 2016; Gorajek et al., 2021). Individual temptations and potential misconducts can be utilized by the monetary authorities to promote wrong decisions. Rybacki (2020) argues that central bank authorities should maintain diversified and versatile economic research to lower deviations of inflation from the central bank target. Unfortunately, this is not always the case. One example is provided by Fabo et al. (2020) who created a meta-analysis of research papers measuring the macroeconomic effects of quantitative easing. Fabo et al. claim that manuscripts presented by central bankers showed stronger and more positive effects compared to papers written by other academics. The most optimistic papers were authored by a senior central bank staff. These examples further motivate the promotion of high-quality research in central banks and highlight the importance of analyzing factors affecting publication success among central bankers. In this research, we focus on the structural drivers of publishing success. Our study may be treated as a starting point for more advanced analyses of publication biases among central bankers.

4 Database

In this section, we discuss the construction of variables used in our research. This research employs information about research papers published by 3312 authors affiliated with one of the 182 international central banks, including international institutions like Bank of International Settlements (BIS) or European Central Bank (ECB). The list of all investigated organizations is presented in Table 1. The publication data are stored in the one of the most widely used databases indexing economic research, namely the RePEc (Research Papers in Economics) database. As stated by the authors, this is a "decentralized bibliographic database of working papers, journal articles, books, book chapters and software components, all maintained by volunteers" (cf. `http://repec.org/`). One of the main services contributing to RePEc is EDIRC (Economics Departments, Institutes and Research Centers in the World), which contains information about instigated central banks. We downloaded available information about authors and their publications using the special RePEc API; the API is discussed in more detail at `https://ideas.repec.org/api.html`.

The RePEc database provides rankings of academic performance based on citations in a similar way to other academic services such as Scopus and the Web of Science. Contrary to the latter services, the metrics in the RePEc database are constructed not only based on high-quality peer-reviewed articles, but also on working papers. The advantage of the RePEc is that this database reflects a wider spectrum of works and allows for a prompter influence of new papers on the h-index statistic than other commercial services allow for. Still, this method leaves space for predatory practices

Table 1: List of institutions analyzed during the research

Africa
Banque d'Algérie, Banco Nacional de Angola, Bank of Botswana, Commission de l'Union Économique et Monétaire Ouest Africaine (UEMOA), Banque de la République du Burundi, Central Bank of Cabo Verde, Banque des Etats de l'Afrique Centrale, Banque Centrale des Comores, Banque Centrale du Congo, Banque Centrale du Djibouti, Central Bank of Egypt, Bank of Eritrea, National Bank of Ethiopia, Central Bank of The Gambia, Bank of Ghana, Banque Centrale de la République de Guinée, Central Bank of Kenya, Central Bank of Lesotho, Central Bank of Liberia, Central Bank of Libya, Banque Centrale de Madagascar, Reserve Bank of Malawi, Bank of Mauritius, Banco de Moçambique, Bank Al-Maghrib, Bank of Namibia, Central Bank of Nigeria, Banque National du Rwanda, Banque Centrale des États de l'Afrique de l'Ouest (BCEAO), Central Bank of Seychelles, Bank of Sierra Leone, Central Bank of Somalia, South African Reserve Bank, Bank of South Sudan, Central Bank of Sudan, Central Bank of Swaziland, Bank of Tanzania, Banque Centrale de Tunisie, Bank of Uganda, Bank of Zambia, Reserve Bank of Zimbabwe
Americas
Banco Central de la República Argentina, Centrale Bank van Aruba, Bahamas Central Bank, Central Bank of Barbados, Central Bank of Belize, Banco Central de Bolivia, Banco Central do Brasil, Bank of Canada, Cayman Islands Monetary Authority, Banco Central de Chile, Banco de la Republica de Colombia, Banco Central de Costa Rica, Banco Central de Cuba, Centrale Bank van Curaçao en Sint Maarten, Banco Central de la República Dominicana, Banco Central del Ecuador, Banco Central de Reserva de El Salvador, Banco de Guatemala, Bank of Guyana, Banque de la République d'Haïti, Banco Central de Honduras, Bank of Jamaica, Banco de México, Banco Central de Nicaragua, Banco Central del Paraguay, Banco Central de Reserva del Perú, Eastern Caribbean Central Bank, Centrale Bank van Suriname, Central Bank of Trinidad and Tobago, Federal Reserve Bank of San Francisco, Federal Reserve Board (Board of Governors of the Federal Reserve System), Federal Reserve Bank of Atlanta, Federal Reserve Bank of Chicago, Federal Reserve Bank of Boston, Federal Reserve Bank of Minneapolis, Federal Reserve Bank of Kansas City, Federal Reserve Bank of St. Louis, Federal Reserve Bank of New York, Federal Reserve Bank of Cleveland, Federal Reserve Bank of Philadelphia, Federal Reserve Bank of Dallas, Federal Reserve Bank of Richmond, Banco Central de Uruguay, Banco Central de Venezuela
Asia
Da Afghanistan Bank, Central Bank of Bahrain, Bangladesh Bank, National Bank of Cambodia, Zhongguo Renmin Yinhang, Hong Kong Monetary Authority, Reserve Bank of India, Bank Indonesia, Central Bank of the Islamic Republic of Iran, Central Bank of Iraq, Bank of Israel, Bank of Japan, Central Bank of Jordan, National Bank of Kazakhstan, Eurasian Development Bank, Asian Infrastructure Investment Bank, Central Bank of Kuwait, National Bank of Kyrgyz Republic, Bank of the Lao PDR, Banque du Liban, Bank Negara Malaysia, Maldives Monetary Authority, Mongolbank, Central Bank of Myanmar, Nepal Rastra Bank, Central Bank of Oman, State Bank of Pakistan, Palestine Monetary Authority, Bangko Sentral Ng Pilipinas, Qatar Central Bank, Saudi Arabian Monetary Agency (SAMA), Monetary Authority of Singapore, Bank of Korea, Central Bank of Sri Lanka, Central Bank of Syria, Central Bank of the Republic of China, National Bank of the Republic of Tajikistan, Bank of Thailand, Banco Central de Timor-Leste, Türkmenistanyň Merkezi Banky, Central Bank of the United Arab Emirates, Central Bank of the Republic of Uzbekistan, State Bank of Vietnam, Central Bank of Yemen

Table 1: List of institutions analyzed during the research (cont.)

Europe
ECB, Bundesbank, Bank of France, Bank of Italy, Bank of Spain, Bank of Portugal, de Nederlandsche Bank, Oesterreichische Nationalbank, Suomen Pankki, Bank of Greece, Bank of Belgium, Central Bank of Ireland, Eesti Pank, Central Bank of Cyprus, Latvijas Banka, Lietuvos Bankas, Banque Centrale du Luxembourg, Bank Centrali ta' Malta, Banka Slovenije, Národná Banka Slovenska, Bank of England, Danmarks Nationalbank, Sveriges Riksbank, Norges Bank, Magyar Nemzeti Bank (MNB), Narodowy Bank Polski, Česká Národní Banka, Banca Nationala a Romaniei, Bulgarian National Bank, Banka e Shqiperise, Central Bank of Armenia, National Bank of the Republic of Belarus, Centralna Banka Bosne i Hercegovine, Hrvatska Narodna Banka, National Bank of Georgia, Sedlabanki Íslands, Banka Qendror e Republikës së Kosovës, Banca Nationala a Moldovei, Centralna Banka Crne Gore (CBCG), Kuzey Kıbrıs Türk Cumhuriyeti Merkez Bankası, Narodna Banka na Republika Severna Makedonija, Central Bank of the Russian Federation, Banca Centrale della Repubblica di San Marino, Narodna Banka Srbije, Bank for International Settlements (BIS), Schweizerische Nationalbank (SNB), Türkiye Cumhuriyet Merkez Bankası, National Bank of Ukraine
Oceania
Reserve Bank of Australia, Reserve Bank of Fiji, Reserve Bank of New Zealand, Bank of Papua New Guinea, Central Bank of Samoa

Source: EDIRC database.

like strategic citing discussed in Section 2. We expect this problem to be relatively small, given that the RePEc is usually not considered as a source of information used for taking financial decisions by scientific authorities, i.e., disposing grants. This issue also leads to another problem. Some authors and journals deliberately decide not to participate in the RePEc or update the list of published articles with significant delays. Therefore, the values of the h-index in the RePEc may differ from the ones reported by other databases. The problem of inconsistencies within metrics between databases is present in all of the bibliometric studies. A more detailed review can be found, for example, in Meho and Rogers (2008), and Seiler and Wohlrabe (2012).
Our retrieved data contain information about papers published between January 1965 and April 2020 (the month when we ran our download scripts). There are 79750 works published either as working papers, articles in peer-reviewed journals, book chapters, or monographs. We were able to derive the following information about central bank researchers from the RePEc database:

1. The h-indices of authors based on the citations available in the CitEc (Citations in Economics) service and using citation information from the RePEc database;

2. The authors' career time span, i.e., the year of each publication, from the first published paper to the last one;

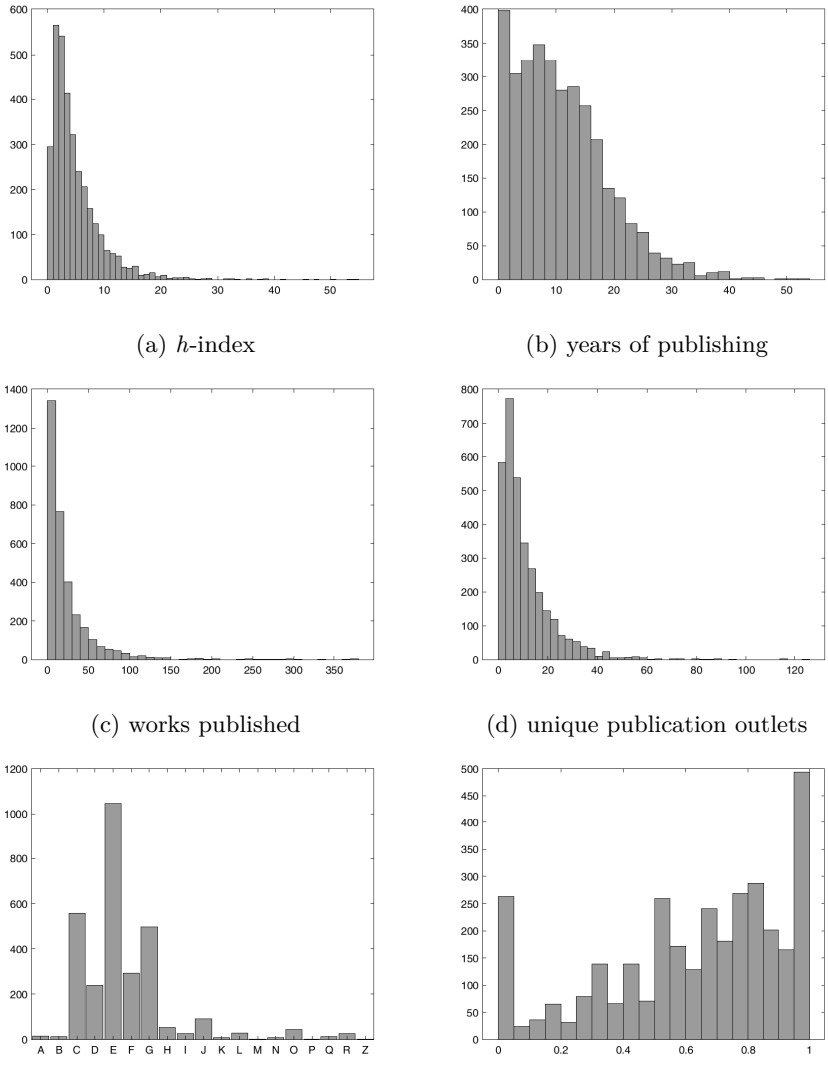
3. The full listing of co-authors of each publication;

4. Information about the number of unique journals where each author published his or her papers;

5. *JEL* (*Journal of Economic Literature*) codes corresponding to the author's papers.

The *JEL* classification system of the American Economic Association "is a standard method of classifying scholarly literature in the field of economics" and its *JEL* codes are used to classify this literature into 20 distinct economic categories (cf. `https://www.aeaweb.org/econlit/jelCodes.php?view=jel`).
Aggregating *JEL* codes by each author, we were able to identify the most frequently researched economic category for each central banker. In our study, we use these leading categories to predict the topics analyzed by central banking scientists that generate the highest (and the lowest) h-index values.
We are interested in measuring the publishing success conditional on the predominant topic of research. One can observe in Figure 1 that studies on monetary policy and inflation (*JEL* code E) have greater priority in comparison to other research categories. We decided to use only main *JEL* categories because the subcategories are too granular and do not allow for meaningful interpretations. We removed authors' publishing papers with categories: K (Law and Economics), M (Business Administration and Business Economics; Marketing; Accounting; Personnel Economics), N (Economic History), P (Economic Systems), and Z (Other Special Topics). The number of corresponding researchers in each case does not exceed 10, which means that central bankers are less interested in these specific topics (cf. Figure 1 (e)).
In addition, we analyze the number of works published by each central banker, the number of publishing years (by subtracting the first publication year from the last publication year of a given researcher), and the number of unique publication outlets (e.g., unique journal names) of each researcher. These statistics are used as the basic discriminatory factors explaining the values of the h-index.
Based on the information about the co-authors of each published work, we also calculate the share of works by a researcher written with at least one co-author. This statistic will help predict the effect of productivity gain from writing research papers in groups. Another related important statistic derived from the RePEc database is the number of co-authors linked to every researcher from a central bank. This statistic is complementary to the previous one in that it provides the size of the research network of a central banker, and it is not necessarily linked to the number of researchers affiliated within a specific central bank. We expected that the size of a research network will be positively correlated with the publication success due to possible productivity and knowledge gains. Researchers with larger research networks are considered to be more open to interactions with other scientists, cooperation initiatives, and new research topics.

Figure 1: Histograms of selected variables used in the study



(a) h-index

(b) years of publishing

(c) works published

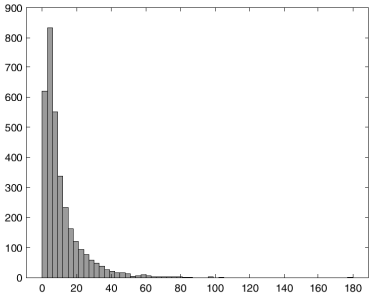
(d) unique publication outlets

(e) dominant *JEL* codes of authors

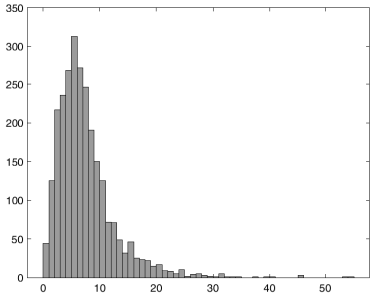
(f) share of co-authored works

Note: All variables are aggregated by specific authors.

Figure 1: Histograms of selected variables used in the study (cont.)



(g) network size



(h) average h-index of co-authors

Note: All variables are aggregated by specific authors.

Table 2: Median value of H-index in selected European institutions

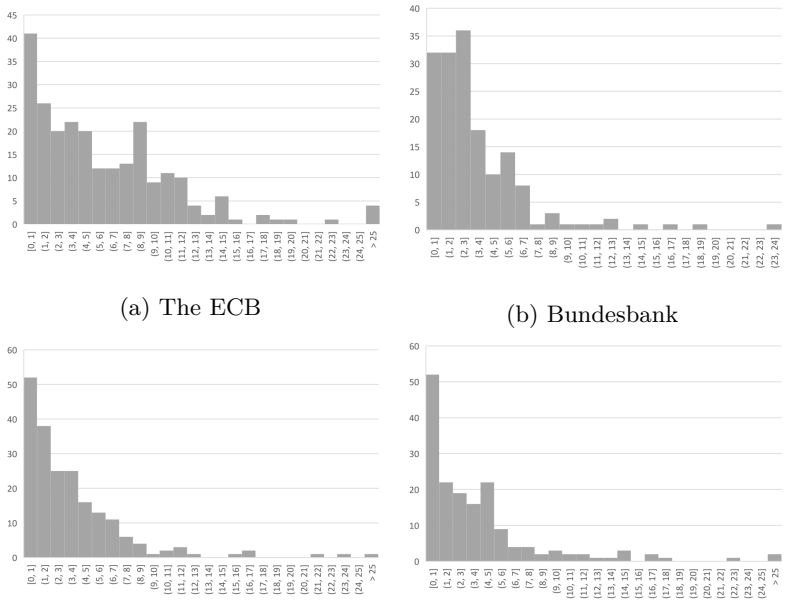
No.	Country / Institutions	H-index	No.	Country / Institutions	H-index
1	BIS	9	14	England	3
2	Austria	6	15	France	3
3	Portugal	5	16	Germany	3
4	ECB	5	17	Netherlands	3
5	Sweden	5	18	Poland	3
6	Finland	4.5	19	Slovakia	2.5
7	Belgium	4	20	Czechia	2
8	Greece	4	21	Latvia	2
9	Italy	4	22	Hungary	2
10	Spain	4	23	Switzerland	2
11	Luxembourg	4	24	Turkey	2
12	Ireland	4	25	Russia	0
13	Norway	4	26	Lithuania	0

Source: RePEc database.

The first look at the dataset reveals that the affiliation of a researcher matters. As an example, median values of the h-index corresponding to authors affiliated within specific European institutions are presented in Table 2. Based on this metric, the Bank of International Settlements seems to be the most influential institution in the field of economics. Moreover, the median h-index value for the European Central Bank is higher in comparison to the majority of central banks participating in the Eurosystem. Unfortunately, the RePEc database does not allow one to directly track

the career progress of central bankers. Therefore, we are unable to analyze whether those institutions recruit people who already possess high h-index values or whether it is the specific affiliation that helps authors in being cited more frequently.
The distribution of the h-index in the majority of institutions is similar to Poisson or a lognormal distribution with a fat tail. The histograms of h-indices in the ECB, the Bundesbank, the Bank of England, and the Bank of France are presented in Figure 2.

Figure 2: The distribution of H-indices in the selected institutions



(a) The ECB

(b) Bundesbank

(c) Bank of England

(d) Bank of France

Source: RePEc database.

Note: The presented distributions are similar to Poisson distribution, albeit there exist some fat tails related to high numbers of very frequently quoted researchers.

There are several explanations for the fact that we observe a relatively high number of researchers with high h-index values. There is a well-known problem of copied citations. Authors automatically cite recognized papers and economists without gaining knowledge about the explicit contents of cited manuscripts (Simkin and Roychowdhury, 2007). Bibliometric analyses also show that top researchers often collaborate with the other leading experts in the field (Ding, 2011). In addition, the personal relationships of researchers frequently do matter. Thus, economists with a

greater number of contacts are more likely to succeed in their academic work (Cisneros et al., 2018).

5 Methodology

This section describes the methodology of our research. We propose a quantitative model predicting the h-indices of authors conditional on their publication characteristics with a Poisson regression.
The Poisson regression formula explaining the value of the h-index with a linear combination of explanatory variables takes the following form:

$$\log\left(\mathbb{E}\left(Y_i|\mathbf{x}_i\right)\right) = \alpha_0 + \alpha_1 x_{1i} + \alpha_2 x_{2i} + ... + \alpha_k x_{ki}, \tag{1}$$

where Y_i is the value of h-index for author i, x_{ji} is the value of j-th control variable for author i, and α_j is the j-th parameter measuring impact of the j-th control variable on Y.
The expected value of the h-index for author i, conditional on information contained in control variables can be measured as

$$\mathbb{E}\left(Y_i|\mathbf{x}_i\right) = \exp(\alpha_0 + \alpha_1 x_{1i} + \alpha_2 x_{2i} + ... + \alpha_k x_{ki}) \tag{2}$$

and the Poisson distribution's probability mass function $p\left(Y_i = y|\mathbf{x}_i\right)$ conditional on independent variables $\mathbf{x}_i$ is given by

$$p\left(Y_i = y|\mathbf{x}_i\right) = \frac{\exp(y \cdot \mathbf{x}_i \cdot \alpha)}{y!} \exp\left(-\exp\left(\mathbf{x}_i \cdot \alpha\right)\right), \tag{3}$$

where $\mathbf{x}_i$ is a vector of independent variables including the constant term, α is a vector of regression parameters, and y is the value of the h-index. We estimate the parameters of the Poisson regression using the maximum likelihood method.

6 Estimation results

We begin by estimating the impact of a publishing time window (Years_i), the number of items published (Manuscripts_i), and the number of distinct publication journals (Journals_i) for each author on the value of the Hirsch index. The Hirsch index depends, by definition, on the number of published papers. It is also well known that the h-index depends heavily on the number of publishing years (Schreiber, 2015). Therefore, we expect a positive impact of all the control variables. The model formula is presented in Equation (4):

$$\log\left(\mathbb{E}\left(Y_i|\mathbf{x}_i\right)\right) = \alpha_0 + \alpha_1 \text{Manuscripts}_i + \alpha_2 \text{Journals}_i + \alpha_3 \text{Years}_i. \tag{4}$$

Table 3 presents the estimation results. Each additional year of publishing experience increases the potential to increase the h-index by approximately 4% (ceteris paribus). This result is robust to different model specifications.

Table 3: Parameter estimates of the Poisson regression with basic control variables

	Estimate	Standard error	t-ratio	p-value
Intercept	0.577	0.016	35.747	0.000
Items	-0.002	0.000	-5.880	0.000
Unique journals	0.031	0.001	26.198	0.000
Years of publishing	0.041	0.001	37.537	0.000
Number of observations	3296			
R-squared	0.39	Mean dependent variable		4.44
Adjusted R-squared	0.39	S.D. dependent variable		4.71
S.E. of regression	3.68	Akaike information criterion		4.28
Sum squared resid	44530.14	Schwarz criterion		4.29
Log likelihood	-7045.63	Hannan-Quinn criterion		4.28
Restr. log likelihood	-11104.43	LR statistic		8118.60

Note: The model is estimated based on Equation (4). The positive parameter for unique journals suggests that successful authors need to diversify their audience and make an effort to cooperate with multiple editorial teams.

Interestingly, the diversity of publication journals plays a more important role than the number of published papers here. This is due to the fact that the number of unique journals and the total number of papers are strongly correlated (e.g., with the Spearman's ρ equaling 0.94 and the Pearson correlation of 0.90), and the journal diversity affects the h-index slightly stronger than the number of publications. According to the results presented in Table 3, each additional unique publication outlet increases the predicted h-index of an author by about 3%. This value decreases to just above 1% when additional factors are considered.

Next, we account for various economic dimensions covered by publications of the analyzed central bankers. We introduce two additional explanatory variables, namely, the number of unique *JEL* codes (JELs_i) and the main *JEL* category identifier ($\text{mainJEL}_{j,i}$, where j=A, B, ..., Z) taking the value of 1 when the leading *JEL* category for a given author is the category j and zero otherwise.

$$\begin{aligned}\log\left(\mathbb{E}\left(Y_i|\mathbf{x}_i\right)\right) &= \alpha_0 + \alpha_1 \text{Manuscripts}_i + \\ &+ \alpha_2 \text{Journals}_i + \alpha_3 \text{Years}_i + \alpha_4 \text{JELs}_i + \sum_{j=A}^{Z} \alpha_{j,5} \text{mainJEL}_{j,i}. \quad (5)\end{aligned}$$

The results are presented in Table 4. Again, the number of unique publishing categories covered by one author does not have an additional positive effect on the

value of the Hirsch index beyond the number of unique publication outlets. Among the three variables, i.e., published items, unique journals, and unique *JEL* codes, the latter one is the least correlated with the h-index variable and it is strongly correlated with the two former variables.

Table 4: Parameter estimates of the Poisson regression with basic control variables and JEL codes

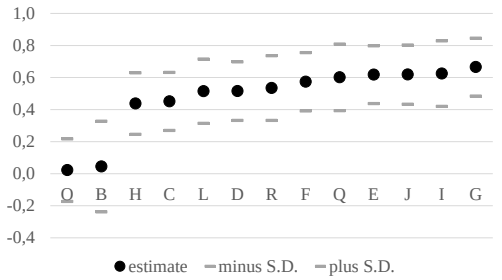
	Estimate	Standard error	t-ratio	p-value
Intercept	0.102	0.180	0.567	0.570
Items	-0.001	0.000	-3.063	0.002
Unique journals	0.029	0.001	23.244	0.000
Years of publishing	0.037	0.001	32.802	0.000
Unique JEL codes	-0.001	0.001	-1.550	0.121
JEL B	0.046	0.283	0.161	0.872
JEL C	0.452	0.181	2.493	0.013
JEL D	0.516	0.183	2.824	0.005
JEL E	0.618	0.180	3.431	0.001
JEL F	0.574	0.182	3.161	0.002
JEL G	0.666	0.181	3.684	0.000
JEL H	0.439	0.192	2.286	0.022
JEL I	0.625	0.204	3.062	0.002
JEL J	0.619	0.185	3.352	0.001
JEL L	0.516	0.201	2.568	0.010
JEL O	0.023	0.195	0.118	0.906
JEL Q	0.602	0.208	2.900	0.004
JEL R	0.535	0.202	2.656	0.008
Number of observations	2926			
R-squared	0.48	Mean dependent var		4.811
Adjusted R-squared	0.48	S.D. dependent var		4.838
S.E. of regression	3.508	Akaike info criterion		4.34
Sum squared resid	35780.44	Schwarz criterion		4.38
Log likelihood	-6330.83	Hannan-Quinn criter.		4.35
Restr. log likelihood	-9913.2	LR statistic		7164.73

Note: The model is estimated based on Equation (5).

Figure 3 presents the sorted impact values of respective *JEL* categories. The highest impact on the h-index is observed for authors publishing research in the areas of financial economics (G), health, education, and welfare (I), labor and demographic economics (J), and macroeconomics and monetary economics (E). While the effects of categories G and E are clear because central bankers are simply specialists in these fields of economics, the publication success of authors in categories I and J may result from the specifics of the general numbers of citations in these areas of science. Nonetheless, most of the other economic categories assert a similar impact

on the h-index. Only the categories containing topics like economic development, innovation, technological change, and growth (O), and the history of economic thought, methodology, and heterodox approaches (B) reveal a significantly lower impact than other categories.

Figure 3: Estimated parameters of respective *JEL* categories



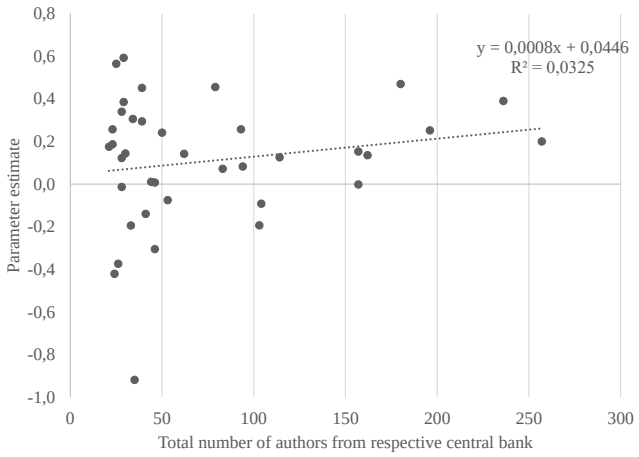
Note: The number of the h-index is significantly higher, especially in the cases of financial economists (G), microeconomists analyzing health, education, and welfare (I), labor and demographic economists (J), and macro and monetary economists (E).

We also control for the authors' affiliations by using dummy variables ($\text{Bank}_{k,i}$, where k is the bank identifier). It is worth noting that several authors have work experience for at least two central banks. There are 300 such researchers. This phenomenon is mostly related to the eurozone region where numerous transfers between national central banks to the European Central Bank take place. For these cases, we select ECB as a leading affiliation. There are also a few transfers to neighboring central banks where authors have similar numbers of published papers, e.g., transfers between the Norges Bank and Riksbank in Scandinavia. In these cases, we attribute affiliation lexicographically. In the mentioned example, authors are assumed to be affiliated with the Norges Bank. There are approximately 30 such cases. We selected the Polish central bank (Narodowy Bank Polski) as a benchmark because the world median level of the h-index is close to the median value observed in this bank.

We analyze how the value of the h-index depends on the central bank that the author is affiliated with. In this analysis, we only study the central banks with at least 20 assigned authors and treat the other banks with fewer authors as the "other banks" group. One disadvantage of this approach is that several central banks with high-quality authors are mixed with central banks with low-quality authors in the same group, but at least we can compare estimated parameters for those central banks with a larger number of authors. Figure 4 presents the relationship between the estimated parameters of central bank identifiers and the numbers of authors affiliated within

the investigated central banks. It shows that no simple link between the number of authors in a central bank and their publishing success exists.

Figure 4: Relationship between estimated parameters of central bank affiliations and the total numbers of authors from respective central banks



Note: The scatter plot shows a weak relationship between the number of authors in a central bank and an estimated parameter corresponding to this institution's dummy variable in Equation (6). Although the variable may be statistically significant, it has a rather weak explanatory power (R-squared equals to 0.03).

This may be discouraging, but affiliation matters. Researchers from the U.S. Federal Reserve Banks, international institutions like BIS, the ECB, or some eurozone central banks have h-index values that are greater by 0.3 to 0.5 pp than researchers from less developed regions. On the other hand, researchers from emerging economies are less frequently quoted despite the fact that large research communities are created in their central banks (e.g., in Russia or in Colombia). Table 6 presents the detailed listing. Quantitative effects of affiliation on the value of the h-index are presented in Table 7. The findings confirm the existence of the so-called *Mathew effect*. The most prestigious institutions are capable of attracting the most talented researchers with higher salaries. The accumulated scientific potential makes applying for new grants easier, which in turn helps maintain leadership positions by these institutions. The phenomenon is visible not only in the world of central banking, but also in the correlation of expenditures and the number of publications in such a prestigious scientific journal as *Nature* (Bogocz et al., 2014). Moreover, experimental studies suggest that journal editors are more willing to publish papers of authors from prestigious institutions than from unknown institutions (e.g., Dadkhah et al., 2015).

Table 5: Parameter estimates of the Poisson regression with basic control variables and JEL codes, central bank affiliation, and the network effects

	Estimate	Standard error	t-ratio	p-value
Intercept	-0.548	0.194	-2.825	0.005
Items	0.001	0.000	2.574	0.010
Unique journals	0.014	0.001	9.707	0.000
Years of publishing	0.039	0.001	31.671	0.000
Unique JEL codes	0.002	0.001	3.047	0.002
Number of authors in a central bank	0.016	0.005	3.244	0.001
Share of works written with co authors	0.684	0.041	16.581	0.000
Network size	0.005	0.001	5.741	0.000
JELs	...	...	...	...
Affiliations	...	...	...	...
Number of observations	2926			
R-squared	0.69	Mean dependent var		4.811
Adjusted R-squared	0.69	S.D. dependent var		4.838
S.E. of regression	7.316	Akaike info criterion		4.03
Sum squared resid	20974.26	Schwarz criterion		4.15
Log likelihood	-5833.44	Hannan-Quinn criter.		4.07
Restr. log likelihood	-9913.20	LR statistic		8159.52

Note: The model is estimated based on Equation (6).

Table 6: Parameter estimates for central bank identifiers

	Parameter estimate	Standard error	t-ratio	p-value
Banco Central do Brasil	-0.7348	0.2603	-2.8232	0.0048
Bank of England	-2.7907	0.9134	-3.0552	0.0022
Bank of France	-2.5381	0.7448	-3.4075	0.0007
Bank of Portugal	-0.5616	0.1984	-2.8302	0.0047
Central Bank of the Russian Federation	-1.2774	0.2222	-5.7481	0.0000
Federal Reserve Bank of New York	0.2235	0.1056	2.1174	0.0342
Oesterreichische Nationalbank	-0.0886	0.1310	-0.6765	0.4987
Schweizerische Nationalbank (SNB)	-1.3186	0.4114	-3.2051	0.0014
Slovenska Narodna Banka	-1.3827	0.3590	-3.8509	0.0001
Banco Central de Chile	-0.8264	0.2229	-3.7068	0.0002
Banco Central de la República Argentina	-0.6909	0.1558	-4.4352	0.0000
Banco Central de Reserva del Peru	-0.8930	0.2052	-4.3516	0.0000
European Central Bank	-3.3345	1.1117	-2.9996	0.0027
Banco de la Republica de Colombia	-1.7663	0.4547	-3.8841	0.0001
Banco de Mexico	-0.5909	0.1762	-3.3537	0.0008
Bank for International Settlements (BIS)	-0.6999	0.3346	-2.0918	0.0365
Bank of Belgium	-0.2868	0.1238	-2.3168	0.0205
Bank of Canada	-2.2463	0.7204	-3.1181	0.0018
Bank of Greece	-0.5641	0.1725	-3.2711	0.0011
Bank of Italy	-3.9146	1.2154	-3.2208	0.0013
Bank of Japan	-0.1864	0.1163	-1.6027	0.1090
Bank of Spain	-1.6597	0.5072	-3.2722	0.0011
Bundesbank	-2.2619	0.7204	-3.1399	0.0017
Central Bank of Ireland	-0.2297	0.1564	-1.4686	0.1419
de Nederlandsche Bank	-1.1669	0.4052	-2.8798	0.0040
Federal Reserve Bank of Cleveland	0.0247	0.1103	0.2238	0.8229
Federal Reserve Bank of Kansas City	0.0179	0.1302	0.1373	0.8908
Federal Reserve Board	-2.2983	0.8334	-2.7576	0.0058
Magyar Nemzeti Bank (MNB)	-0.5667	0.1562	-3.6285	0.0003
Narodowy Bank Polski	-0.6044	0.1886	-3.2052	0.0013
Norges Bank	-0.0087	0.1201	-0.0725	0.9422
Reserve Bank of Australia	0.1693	0.1241	1.3642	0.1725
Reserve Bank of New Zealand	0.0478	0.1668	0.2866	0.7744
State Bank of Pakistan	-0.3342	0.1506	-2.2182	0.0265
Suomen Pankki	-0.4927	0.1161	-4.2448	0.0000
Sveriges Riksbank	-0.0609	0.1490	-0.4091	0.6825
Central Bank of the Republic of Turkey	-1.6986	0.4610	-3.6843	0.0002
Federal Reserve Bank of Chicago	0.3107	0.0967	3.2140	0.0013

Note: Other model parameter estimates are presented in Table 5. All parameters are estimated based on Equation (6). The table suggests that economists from the U.S. Federal Reserve Board and some Euro area central banks are more frequently cited compared to the National Bank of Poland. On the other hand, analysts from big emerging economies like Russia and Turkey receive lower number of citations. However, this is not the full effect of affiliation because the full effect should also consider the impact of the number of affiliated scientists in a given central bank according to Equation (6).

Table 7: Impact of affiliation on publication success

Central bank	Number of affiliated authors	Effect related to the number of authors	Other effects of central bank affiliation	Total effect on log(h-index)
Central Bank of the Russian Federation	35	0.564	-1.277	-0.714
Banco Central de la Republica Argentina	24	0.386	-0.691	-0.304
Banco Central de Reserva del Peru	46	0.741	-0.893	-0.152
Banco de la Republica de Colombia	103	1.659	-1.766	-0.108
Suomen Pankki	26	0.419	-0.493	-0.074
Slovenska Narodna Banka	83	1.337	-1.383	-0.046
Magyar Nemzeti Bank (MNB)	33	0.531	-0.567	-0.035
Central Bank of Turkey	104	1.675	-1.699	-0.024
Banco Central de Chile	53	0.853	-0.826	0.027
Banco de Mexico	41	0.660	-0.591	0.069
Bank of France	162	2.609	-2.538	0.071
State Bank of Pakistan	28	0.451	-0.334	0.117
Narodowy Bank Polski	46	0.741	-0.604	0.136
Bank of Greece	44	0.709	-0.564	0.144
Bank of Spain	114	1.836	-1.660	0.176
Schweizerische Nationalbank (SNB)	94	1.514	-1.319	0.195
Bank of Belgium	30	0.483	-0.287	0.196
Bank of Italy	257	4.139	-3.915	0.224
Bank of Portugal	50	0.805	-0.562	0.244
Banco Central do Brasil	62	0.998	-0.735	0.264
Bank of Japan	28	0.451	-0.186	0.265
Bundesbank	157	2.528	-2.262	0.266
Bank of Canada	157	2.528	-2.246	0.282
de Nederlandsche Bank	93	1.498	-1.167	0.331
Bank of England	196	3.156	-2.791	0.366
Reserve Bank of New Zealand	21	0.338	0.048	0.386
Federal Reserve Bank of Kansas City	23	0.370	0.018	0.388
Federal Reserve Bank of Cleveland	23	0.370	0.025	0.395
Central Bank of Ireland	39	0.628	-0.230	0.398
Norges Bank	28	0.451	-0.009	0.442
Oesterreichische Nationalbank	34	0.548	-0.089	0.459
ECB	236	3.800	-3.335	0.466
Sveriges Riksbank	39	0.628	-0.061	0.567
Bank for International Settlements (BIS)	79	1.272	-0.700	0.572
Federal Reserve Board	180	2.899	-2.298	0.600
Reserve Bank of Australia	29	0.467	0.169	0.636
Federal Reserve Bank of New York	29	0.467	0.224	0.691
Federal Reserve Bank of Chicago	25	0.403	0.311	0.713

The final stage of our research is the analysis of network effects on publication achievements. We not only investigate the number of authors affiliated within a central bank as a separate explanatory variable in the model (AuthorsInBank_i), independent of central bank identifiers, but we also include two variables describing co-authorship networks. The first variable measures the share of papers written with co-authors (ShareCoAuthors_i), as the co-authorship should theoretically increase the efficiency of produced research output. The second variable measures the network size of distinct co-authors (NetworkSize_i). The high number of co-authors widens the potential area of research, increases the potential to develop publication skills, and helps avoid dead ends, i.e., sticking to research topics that are uninteresting for readers and other researchers. The final equation is the following:

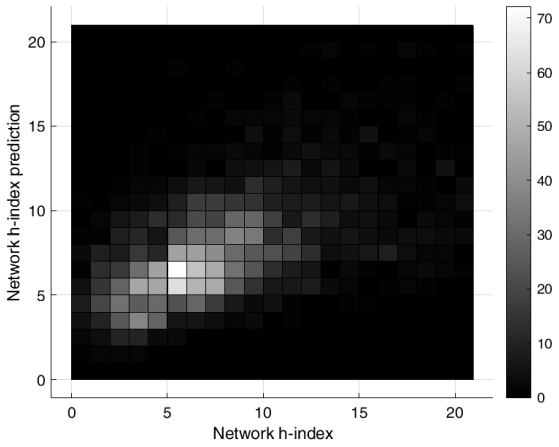
$$\begin{aligned}\log\left(\mathbb{E}\left(Y_i|\mathbf{x}_i\right)\right) = \alpha_0 + \alpha_1\text{Manuscripts}_i + \alpha_2\text{Journals}_i + \alpha_3\text{Years}_i + \\ + \alpha_4\text{JELs}_i + \sum_{j=A}^{Z}\alpha_{j,5}\text{mainJEL}_{j,i} + \ \alpha_{k,6}\text{Bank}_{k,i} + \\ + \alpha_7\text{AuthorsInBank}_i + \alpha_8\text{ShareCoAuthors}_i + \ \alpha_9\text{NetworkSize}_i. \quad (6)\end{aligned}$$

It is clear that co-authorship networks are not only built within a single bank, but may have much greater inter-institutional coverage. A simple correlation analysis confirms this presumption. The correlation of the number of authors within a single institution with the two other network variables is weak, which suggests that successful authors are more prone to building international research networks. What is important, however, is that the two other network measures have a strong statistical impact on the value of the h-index, while the size of a publishing group in a bank has a somewhat weaker but still significant effect. The most important variable seems to be the network size because it is the most correlated with the Hirsch index, but it is also correlated with the number of articles written and the number of distinct publication journals of the same author. Therefore, the effect of the co-authorship network size is not the most strongly pronounced in the Poisson regression. Nevertheless, the h-index of the researcher who wrote all the papers with co-authors is almost 100% ($\exp(0.684) - 1$) greater than the h-index of an author who works alone. The results of the parameter estimates are presented in Table 5.

As a robustness check, we also analyzed bootstrapped standard errors of parameter estimates as in Manly (2011) and obtained qualitatively the same results to those presented in Table 5. All the statistically significant variables remain significant. The estimated values are also very similar, with the exception of the constant term and central bank binary variables because some bootstrap samples affect the precision of respective parameter estimates when specific banks have very few observations. We conclude that our general results are robust to potential model misspecification.

We also analyze the average h-index (Figure 5) of all co-authors of a given author and call it "Network h-index" (NetworkHIndex_i). We expect the dependence between

Figure 5: Bivariate histogram of the H-index and network H-index variables



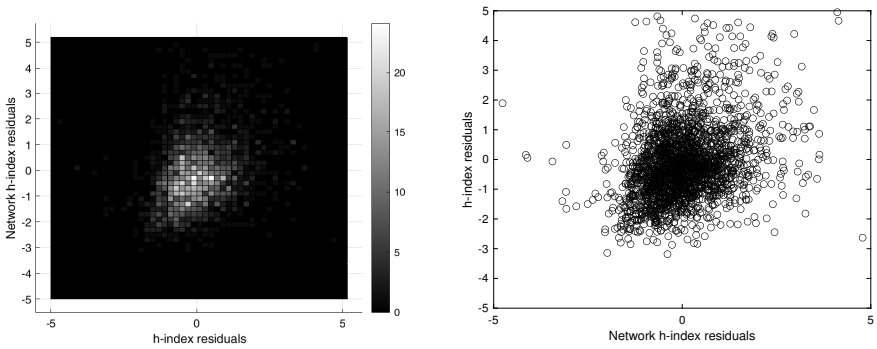
Note: Dark colors denote less frequent cases and light grey colors denote more frequent cases in the histogram.

this variable and the original h-index to be bidirectional. Highly skilled co-authors have a higher likelihood of cooperating with successful authors. On the other hand, a frequently cited author finds good-quality authors more easily than an inexperienced author does. In order to compare the Network h-index with the original h-index of an investigated author, we round Network h-index values to integer numbers and run a Poisson regression of the transformed variable on the same set of explanatory variables as we did for the original h-index variable. The set of explanatory variables is the same as in Equation (6).

$$\begin{aligned}\log\left(\mathbb{E}\left(\text{NetworkHIndex}_i|\mathbf{x}_i\right)\right) = \alpha_0 + \alpha_1\text{Manuscripts}_i + \alpha_2\text{Journals}_i + \\ + \alpha_3\text{Years}_i + \alpha_4\text{JELs}_i + \sum_{j=A}^{Z}\alpha_{j,5}\text{mainJEL}_{j,i} + \\ + \alpha_{k,6}\text{Bank}_{k,i} + \alpha_7\text{AuthorsInBank}_i + \\ + \alpha_8\text{ShareCoAuthors}_i + \alpha_9\text{NetworkSize}_i. \qquad (7)\end{aligned}$$

Standardized residuals from this regression are then compared with standardized residuals of the h-index regression. Figure 6 presents a histogram and a scatter plot of both residuals from the regressions (6) and (7).
The Pearson, Kendall, and Spearman correlations between the h-index and Network h-index residuals are equal to 0.196, 0.288, and 0.243, respectively, and they are all

Figure 6: Bivariate histogram and scatter plot of the H-index and network H-index



(a) Histogram (b) Scatterplot

Note: Dark colors denote less frequent cases and light grey colors denote more frequent cases in the histogram.

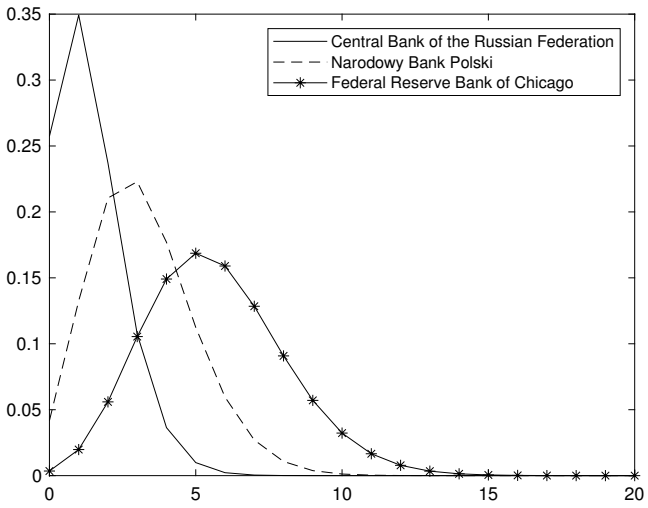
statistically significantly different from zero with p-values lower than 0.01. These results indicate that publishing success is positively correlated with the average h-indices of co-authors even after controlling for the impact of control variables like the number of publications, size of the co-authorship network, research area, and central bank affiliation.

These results suggest that large social networks and cooperation with distinct scholars are important factors supporting publication careers in central banks. The literature reveals some motivation behind this phenomenon. Some studies suggest that collaboration improves both understanding of economic processes and research productivity (Ductor, 2015; Lee and Bozeman, 2005). Moreover, those researchers who collaborate publish more, and, therefore, they are less exposed to the risk of prolonged reviews and rejections (Barnett et al., 1988). Finally, research grants provide financial incentives for cooperation with other scientists (Ductor, 2015).

7 Conclusions

This research enables the prediction of the h-index for a central banker based on her publication, affiliation, and research topic characteristics. An author with median numbers of published works (15), unique publication outlets (8), publication years (10), unique *JEL* codes (12), share of co-authors (67%), and network size (7), with the main interest in monetary economics (*JEL* code equaling E), and affiliated with the Polish central bank (together with 46 affiliated authors) has a predicted h-index equaling approximately 3 (cf. Figure 7).

Figure 7: Probability distribution functions of H-index values for authors from three selected central banks



Note: The probability distributions are conditional on the number of published works (15), unique publication outlets (8), publication years (10), the number of unique JEL codes (12), share of co-authored papers (67%), network size (7), the main interest in monetary economics (JEL code equaling E), and on a central bank affiliation and the number of authors in a given central bank. Calculations are based on Formula (3) and Estimation Equation (6).

An author with the same characteristics has a predicted h-index above 5 if she is affiliated with the Federal Reserve Bank of Chicago (25 affiliated authors), and just above 1 if affiliated with the Central Bank of Russian Federation (35 affiliated authors). These predictions suggest that affiliation of a central banker provides a good benchmark to assess potential for the number of citations. At the same time, this is a challenge for central banks in emerging economies. The experiences of federal reserve banks may not be appropriate for Asian or South American economies. Therefore, more effort for increasing regional collaboration between researchers should be beneficial.

We are aware that analyzing data on researchers' salaries and education, as well as changes of affiliations through time, would bring more information regarding the impact of affiliations on publishing success. Future analyses may fill this gap.

Our research also confirms that the chosen research dimension has an impact on the number of citations. Among the most cited areas are the topics related to financial and monetary economics. This empirical fact provides a good opportunity for central banks to communicate their policies and establish a solid reputation.

Networking affects publishing success. This result immediately suggests that banks

with larger research departments generate more successful publications. In the wake of a prolonged period of missing the inflation target, central bank authorities should investigate whether such an approach does not lead to problems when researchers become overly supportive to their closest collaborators. Interestingly, the network of co-authors does not have to be related to the size of the local central bank community because the size of the publishing network improves the potential for publishing success even after controlling for the number of colleague authors working in the same banking institution. Networks are often developed among foreign partners, e.g., during scientific workshops and conferences, and may be related to other factors like friendships or common research interests of scientists.

Our research finds that the net of highly skilled co-authors is positively associated with the number of cited papers of a given author. The causality may be bidirectional, but it indicates that cooperation with more experienced authors improves the chances of publishing success in addition to the number of co-authors in general. This link, as well as factors explaining differences among central banks, could be further investigated in future analyses.

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