

Public Policy and Scientometrics of Dissertations in Computer Science: Russian Authors' Indexing in the Web of Science/Scopus Databases

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Abstract - The work is aimed at studying the dynamics of scientometric indicators of Russian science in the last 5-10 years. We observe a strong increase in the number of Russian works indexed by the Web of Science (WoS) and/or Scopus databases, and this trend is the result of special government projects. Our analysis of defended dissertations in the areas of Mathematical Modeling, Numerical Methods and Scientific Software shows active transition to publications in journals indexed by WoS/Scopus in all regions of Russia. These changes are due, in particular, to the rapid growth in the number of Russian scientific journals indexed by international bibliographic databases.

Keywords—*bibliographic databases; Computer Science; Web of Science; Scopus; dissertation researches; scientometrics*

I. INTRODUCTION

The use of scientometric indicators is a general trend of cooperation between the scientific community on the one hand, and the state and scientific foundations on the other hand [1]. Negative criticism of the use of scientometric tools for evaluating scientific activity is widely discussed [2, 3], but scientometric indicators become the basis for assessing academic achievement and for making funding decisions through both public and private foundations in modern science [4, 5]. The almost complete victory of scientometrics is due to the huge amount of heterogeneous scientific research (millions of scientists and hundreds of scientific fields) and the simplicity of administration and management of scientific institutions with this approach.

We see the formation of scientometrics into the special scientific branch, and special adapted tools for analyzing and visualizing big data are created for it [6, 7]. The opinion is being formed that scientometric approaches can provide foresight on future trends and act as a tool in future studies [4].

The Web of Science bibliographic database (WOS, until 2016 the system was called the Web of Knowledge of Institute for Scientific Information and then the media

company Thomson Reuters) is central to the scientometric analysis of scientific publications. But Elsevier Science provided the new Scopus (SciVerse Scopus) database in 2004, and it became a good additional scientometric tool. A comparison between Scopus and ISI Web of Science shows that these systems have no competitors in terms of functionality and possibilities of working with citation data [8, 9]. They are universal databases, so WoS and Scopus benefit in terms of data coverage compared to specialized ones, for example, PubMed, MathSciNet, zbMATH, Springer, Chemical Abstracts. But the main thing is the hard and qualified selection for including scientific journals and books in these databases.

We are seeing a growing interest in evaluating the effectiveness of scientific research based on scientometric characteristics, which is accompanied by the development of new methods and indicators for such evaluations [1, 7, 10, 11]. Such studies compare publications (journal, book, conference proceedings) in terms of research areas, semantics, languages, countries, institutions, affiliations, financial support, types of publications, definition of scientific schools, citation, article lifetime, etc.

A small share of Russian authors in international scientific journals has a long history and is determined by multiple cause. First of all, this is due to government policy until about 1990. Social and public factors were superimposed on this, including the insufficient distribution of good English, a negligible academic exchange between Soviet and foreign universities and research institutes. A small number of so-called translated Soviet scientific journals were published simultaneously in Russian and English. Subjects of such journals related primarily to the physical and chemical sciences, so we highlight the following journals "Soviet Physics Uspekhi", "Soviet Physics JETP", "Soviet Physics. Solid State", "Soviet physics. Technical physics", "Soviet Journal of Nuclear Physics", "Doklady Akademii Nauk SSSR", "Izvestiya Akademii Nauk Sssr" (various series), "Astrophysics", "Soviet Astronomy Letters", "Soviet Astronomy",

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"Combustion, Explosion, and Shock Waves", "Journal of Organic Chemistry of the USSR".

The most important event was the creation in 1992 of the International Academic Publishing Company "Maik Nauka - Interperiodica Publishing" due to the efforts of the Russian Academy of Sciences, the American company Pleiades Publishing, Inc. and publishing house "Nauka". The new company allowed maintaining the academic potential despite the very negative socio-economic situation in Russia in the last decade of the 20th century.

We analyze the dynamics of publications of Russian authors in journals, books and conference proceedings, which are indexed by international scientific databases, in particular, based on statistics of successfully defended dissertations in subject categories of mathematical modeling, numerical methods and software systems.

II. PROBLEMS OF PUBLICATION ACTIVITY OF RUSSIAN AUTHORS

A. The need for a new state policy

The official government document "Forecast of the socio-economic development of the Russian Federation for 2012 and the planned period of 2013-2014" in the section "Current status and development trends of the scientific, technical and innovation spheres" indicates Russia's low representation in world science. Russia's share in the global number of citations in scientific journals in 2005–2009 was less than 1%. In 2009, Russian science produced less than 1.8% of the global number of publications in scientific journals indexed in the Scopus database, while France – 4.4%, Germany – 5.9%, China – 15.1%, USA – 20.9%. This indicator was for Russia at the level of the Netherlands (2%) and Taiwan (1.8%). In addition, Russian science was characterized by low productivity of work of scientists (in 2009, 100 researchers accounted for 7 publications in scientific journals, indexed in Scopus, whereas this parameter was 47 in the UK, 35 in Germany, 27 in the USA).

Special government program was developed to change these negative trends. Let us highlight some public policy measures that are aimed at increasing the Russian share of research papers in international publications.

The new direction of state policy was requirements that the Higher Attestation Commission (HAC, as a division of the Ministry of Science and Higher Education of the Russian Federation) has submitted to dissertations for degrees of Candidate of Sciences (PhD analogue) and Doctor of Sciences (Doctor Habilitatus analogue). Initially, there was a requirement to publish the main results of the dissertation research in scientific journals, which are indexed in Web of Science (WOS), Scopus, Astrophysics, PubMed, Mathematics, Chemical Abstracts, Agris, GeoRef, Springer, BioOne databases. In 2018, publications in the WoS, Scopus, PubMed, MathSciNet, zbMATH, Chemical Abstracts, Springer, GeoRef databases were equated to the status of scientific publications that are included in the HAC List. An important step was the requirement for members of dissertation councils to have a certain number of publications indexed in WoS/Scopus. Finally, it was decided that publications in WoS or Scopus are a necessary condition for defending dissertations. The last condition will become mandatory only from 2020. However, the academic

community began to take a positive view of this requirement and to take into account in its work at all levels, from graduate students to the HAC expert councils.

The science funds of Russia change grant conditions and reporting requirements so that articles in high-rating journals with quartiles Q1, Q2 become a very important factor for a successful outcome.

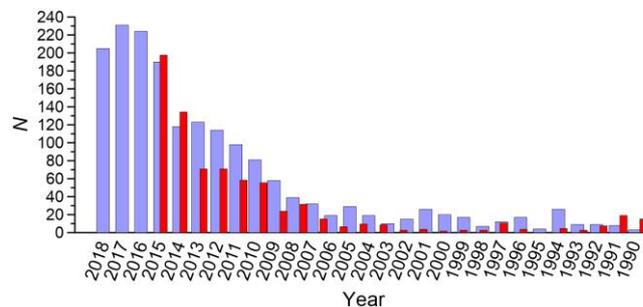


Fig. 1. Distribution of the number of publications of Russian authors in the field of scientometrics by years. We consider publications indexed by Web of Science only (blue chart). The red chart shows the distribution of publications in the field of scientometry only in Russian journals [18].

The annual reporting of the universities and the scientific institutions of the Russian Academy of Sciences is also aimed at increasing the publications number indexed in WoS/Scopus. The internal policy of universities and institutes of the RAS is changing dramatically under the external impact of state structures, which leads to the formation of new methods of financial and administrative management, which are aimed at increasing publications in high-quality journals. At present, we see the transition of government agencies exclusively to WoS and Scopus bibliographic databases to record the results of scientific activities, and the first system has an advantage.

Several important actions to improve the quality of scientific research in Russia were carried out by the Government and the Presidential Administration of Russia, in particular, such event was the presidential decree of May 7, 2012 No. 599 "On measures for implementation of the state policy in the field of education and science". The main purpose of this decree was to increase the number of Russian publications in the WoS database by 2015 and these actions had a positive effect on the dynamics of articles number in high-rating journals.

B. Scientometric studies in Russia

Russia is one of the founders of scientometric research since the term "Scientometrics" was introduced by a professor at Moscow University Vassily Nalimov (1910-1997) [12], and this term is widely used, as evidenced by the title of the leading journal "Scientometrics" [13, 14]. Irina Marshakova (1973) [15] in the Soviet Union and, independently, Henry Small [16] developed the method of co-citation, which is an important element of the theoretical foundation of modern scientometrics.

The arsenal of scientometric tools contains various methods for evaluating research, but the attention of administrators and scientists is concentrated around citing as a key concept. Citation indices based on bibliographic databases are the most popular tools for tracking new scientific articles and evaluating them. Citing the works of

other authors is able to provide connections between people, their works, journals, institutions and even countries [17].

Russian scientometrics experienced both ups and downs. The reasons of the current state of Russian science, the detection of factors that ensure both the growth and decline of scientometric indicators, the relationship between these characteristics and the government policy have been studied actively in recent years [11, 15, 18, 19].

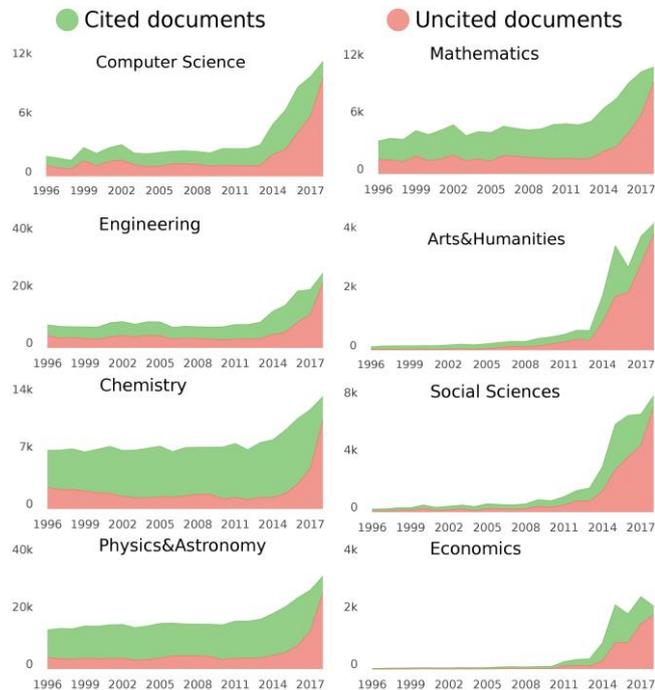


Fig. 2. Scopus data on publication activity of authors with Russian affiliation for various scientific fields (SCImago, (n.d.). SJR — SCImago Journal & Country Rank [Portal]. Retrieved 30 May 2019, from <http://www.scimagojr.com>)

The organization of the research system includes financial conditions, monitoring of scientific activities results and administrative management, and these components have undergone significant changes in Russia due to a number of government reforms and projects aimed at improving the competitiveness and increasing the international status of Russian universities.

To demonstrate the dynamics of high-quality publications in the field of scientometrics, we constructed the distribution of the number of scientific publications N (Figure 1), which shows an insignificant level until about 2006. Then we see the growth that corresponds to the overall growth in the publication activity of Russian authors in all scientific fields, which is due to a change in government policy, in particular, pay reform in science and education. But after 2014, the doubling of N indicates new trends in the development of Russian science.

C. Analysis of the first results of government policy

We reviewed publication activity and citation of authors with Russian affiliation based on the Country Rankings tool of the SJR resource (SCImago Journal & Country Rank). Fig. 2 shows the dynamics of the number of publications by Russian authors over the past 22 years in various scientific fields, where the number of cited and non-cited documents is highlighted separately.

The explosive dynamics of the number of publications is observed after 2012. We can distinguish two groups of scientific areas: I — Mathematics, Physics&Astronomy, Chemistry, Engineering, Agricultural and Biological Sciences, Biochemistry, Genetics and Molecular Biology, Chemical Engineering, Earth and Planetary Sciences, Energy, Environmental Science, Immunology and Microbiology, Materials Science, Medicine, Neuroscience, Pharmacology, Toxicology and Pharmaceuticals; II — Computer Science, Arts&Humanities, Social Sciences, Economics, Business, Management and Accounting, Decision Sciences, Health Professions. The first group is characterized by growth in the range of 1.5 – 3 times over the past 5 years (2013 - 2018). The relative growth of the second group is stronger and ranges from 3 to 10 times.

In general, all subject areas give 94427 publications for 2012-2013 and 188591 for 2017-2018. The total growth is only 2 times due to the fact that the total number of publications of the first group is dominant compared to the total number of publications in the second group. We have the so-called low base effect for the second group.

An almost double increase in the total number of publications and a 5-20-fold increase in some scientific areas over 5 years is an unusual phenomenon, and this was not observed during the entire statistical period (1996-2017) for USA, Germany, Netherlands, United Kingdom, Sweden, France, Japan and others. Moreover, we see a strong slowdown in the growth of $N(t)$ and a plateau in a number of countries, for example, Netherlands, South Korea, China, Sweden, Australia, Spain, Finland, Italy. Finally, Japan, Canada, France, USA even show a slight decrease in N .

D. Ranking dynamics of Russian scientific journals

Figure 3 shows the change in the distribution of Russian journals by quartiles in the Scopus database in 2012 and 2018. We see a double increase in the N_j parameter, with a redistribution in quartiles indicating an improvement in the quality of these journals (Q1 or Q2). A proportion of journals without a quartile (Q_{not}) is due to new journals that have not yet received an impact factor.

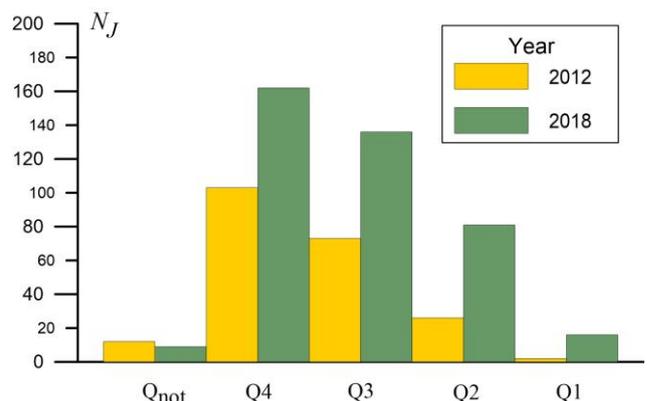


Fig. 3. Distribution of Russian journals by quartile in the Scopus database (Q_{not} indicates the absence of quartile)

E. Necessity to move to the model of the open access publications

The current practice of publishing scientific journals is characterized by various models of interaction between authors (A), publishers (P) and readers (R) (Fig. 4).

Additional subjects are institutions (universities, research institutes, research departments of companies, etc.) in which Authors (AO) or Readers (RO) work. The arrows I - VI show the directions of possible financial flows. For example, The Astrophysical Journal (Institute of Physics Publishing) is characterized by the AI-AOII-RIV-ROIII scheme, and Astronomy Reports (Maik Nauka/Interperiodica Publishing) has the scheme AOII-RIV-ROIII-AIV. We emphasize that the publisher cannot influence the presence of flow between AO and A (See V in Figure 4). In Russia, we have situations that are rare in developed countries, when the Publisher pays Authors (for example, the MAIK journals) and the institution pays special premium to Authors besides financing through grant funds.

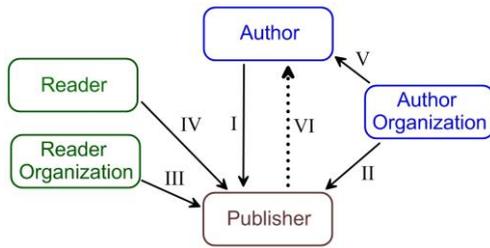


Fig. 4. The patterns of interaction between three main subjects of scientific activity

Obviously, the flows of type I are not acceptable for the Russian scientific community if the increase in the journal impact factor is determining task. The lack of available free full-text articles is a key problem. The noticeable part of articles in Russian journals indexed in WoS/Scopus is written only in Russian, and this additionally greatly reduces the chances for reading and subsequent citation in high-rating journals. The transition to an open access publications model is the easiest solution for academic journals owned by universities.

III. ANALYSIS OF THE DISSERTATIONS IN COMPUTER SCIENCE

A. Data sets from databases

Scientometric indicators are highly dependent on discipline, so we must consider individual scientific fields. Let us consider the dynamics of the number of publications from the WoS/Scopus databases that underlie candidate and doctoral dissertations in Russia.

Figure 2 and the discussion in paragraph 2 show that the dynamics of publication activity in the humanitarian, socio-economic, business, management areas differs from the physical, mathematical, technical and natural areas. Computer Science belongs to the technical or mathematical fields, but its publication activity stands out because it shows an increase of 3.6 times since 2013. Therefore, we will consider this scientific area in more detail, based on the analysis of dissertations defense, both candidate and doctoral levels. Computer Science is equivalent to the term "Control, Computer Engineering and Informatics" (CCEI), which is used by the Higher Attestation Commission in Russia. This council administers several scientific specialties for which Figure 5 shows the number of dissertations defenses in 2018 (Table I).

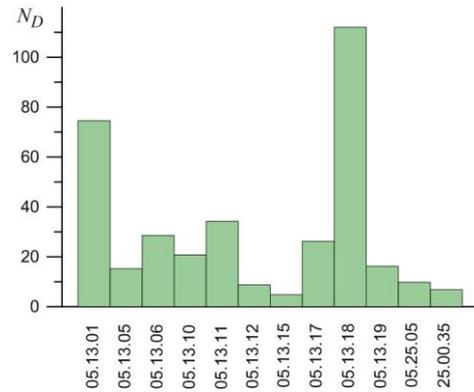


Fig. 5. Distribution of the number of dissertations in various subject categories of Computer Science in 2018

Specialty 05.13.18 Mathematical Modeling, Numerical Methods and Program Complexes is the most popular one (more than 30 percent of the total number of dissertations on CCEI) and covers a wide range of problems of numerical modeling in almost any subject areas of science and technology. The number of dissertation councils in the specialty 05.13.18 is 63, and they work in 36 regions of Russia (Fig. 6).

TABLE I. LIST OF HAC SPECIALTIES IN THE FIELD OF COMPUTER SCIENCES

Code	Name
05.13.01	System analysis, control and information processing
05.13.05	Elements and devices of computers and control systems
05.13.06	Automation and control of technological processes and production
05.13.10	Management in social and economic systems
05.13.11	Mathematical Support and Software for Computers, Computing Complexes and Computer Networks
05.13.12	CAD Systems
05.13.15	Computers, complexes and computer networks
05.13.17	Theoretical foundations of computer science
05.13.18	Mathematical Modeling, Numerical Methods and Program Complexes
05.13.19	Information Protection Methods and Systems, Information Security
05.25.05	Information systems and processes
25.00.35	Geoinformatics

We used the input data on publications when performing dissertation research from the web resource of the Higher Attestation Commission, capturing articles in scientific journals, which are indexed by the Web of Science and/or Scopus bibliographic databases using the SCImago Journal Rank (SJR) and Clarivate Analytics services.

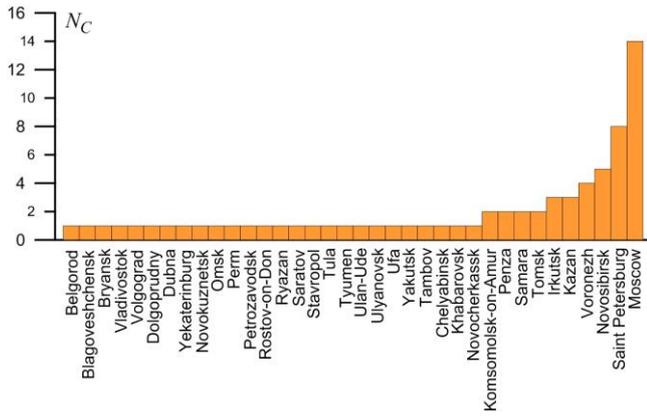


Fig. 6. Distribution of the number of dissertation councils in the specialty 05.13.18 by regions of Russia

B. Dynamics of the number of publications indexed in WoS/Scopus

The distribution of articles in dissertations in the specialty 05.13.18 indexed by WoS / Scopus is very uneven across the regions of Russia, due to the dominance of scientific organizations and universities in Moscow (Dubna and Dolgoprudny are part of the Moscow region) and St. Petersburg (Fig. 7). Only 24 Federal subjects from 82 regions have non-zero indicators.

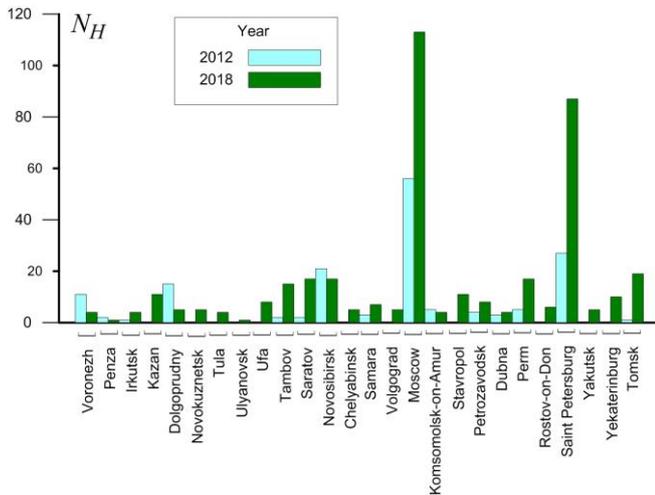


Fig. 7. Distribution of the number of publications indexed by WoS/Scopus (N_H) for dissertations on 05.13.18 in various cities

Figure 8 shows the distribution of the coefficient $k = N_H / (N_H + N_{HAC})$ (N_H is the number of publications that are indexed by Web of Science or Scopus, N_{HAC} is the number of publications from the List of the Higher Attestation Commission, which are mandatory for a scientific dissertation) for different regions in 2012 and 2018, where dissertation research was carried out. The dissertations are based mainly on articles indexed by international databases in the case of $k > 0.5$ (See Fig. 8).

We see a significant expansion in the geography of dissertational works, which are significantly based on publications in WoS/Scopus and an increase in the share of publications in higher-rated international publications in recent years. The Siberian and Ural cities are very strongly represented.

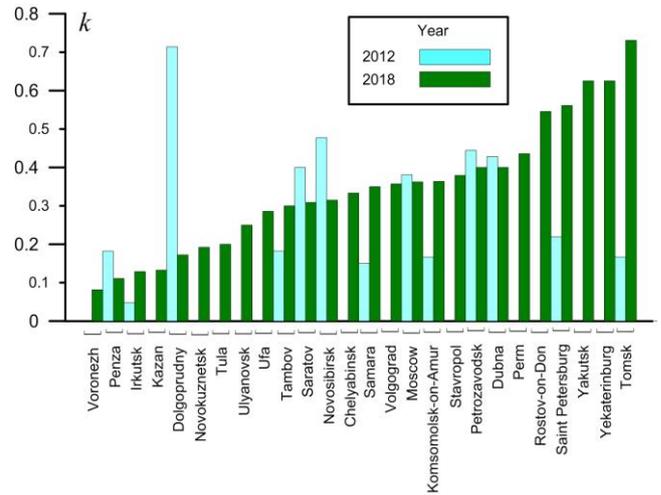


Fig. 8. Distribution of the parameter k by region

C. Gender Policy

Gender policy in the scientific community is a topical issue that causes increased attention from different perspectives since statistics in most cases indicate inequality. Comparisons of scientometric indicators of men and women indicate noticeable differences in the number of publications, collaboration, and degree of scientific influence [20, 21]. It is believed that the representation of women in academic activities is an important indicator of gender equality in the country, but the analysis of academic journals gives a low female publication activity in mathematical and physical journals especially (at about 10%), although we observe a slight improvement in recent years [21]. Despite the growing share of women in the field of science, all studies over the past decades prove that articles with male authors are ahead in both the number and the number of citations [22]. The overall situation is improving in most countries, but it is uneven.

The situation in Russia is highly dependent on the socio-economic, political and historical context of the country. Analysis of WOS data for different disciplines from 1973 to 2012 in [20] shows that the proportion of women is lower (less than 30 percent) than men in all disciplines except psychology, and it is especially small in mathematical disciplines (about 7 percent).

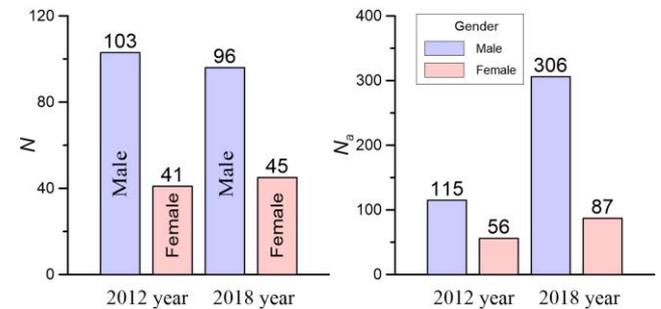


Fig. 9. Gender distribution of the number of dissertations N (left) and the number of articles underlying the dissertations that are indexed in WoS/Scopus N_a (right)

We have done our gender analysis of data on defended dissertations in the field of Computer Science in the last decade. Fig. 9 shows that the number of dissertations according to the Higher Attestation Commission with female

authorship in 2012 and 2018 is less than that of men and is 28 percent in 2012 and 32 percent in 2018 respectively, which is significantly more than in physical or engineering sciences. The number of publications in scientific journals indexed in WoS/Scopus has decreased since 2012, although the total number of publications has increased.

IV. CONCLUSION

We conclude on significant changes in the scientometric indicators of Russian authors due to the government policy of the Russian Federation over the past decade. Significant quantitative growth has been observed for all scientific fields since 2012. Such growth was in some developing countries earlier, which then transformed into a weak increase or even a plateau. Scientometric indicators of research in Computer Science stand out among the physical, mathematical and technical research areas, and we have examined these characteristics in detail for dissertations in subject areas of Mathematical Modeling, Numerical Methods and Scientific Software. The strong increase in the number of publications indexed in WoS / Scopus over the past approximately 5 years is highly heterogeneous for various scientific fields. This growth is explosive for areas such as for the Art, Humanities, Economics, Econometrics and Finance (4 – 15 times) and it is weaker for physical, mathematical and natural areas (1.5 – 3 times). Intermediate dynamics demonstrate Computer Science (more than threefold growth). These achievements are due to government policies and the construction of a new system of relationships between the scientific community and the government agencies.

The number of Russian journals indexed in WoS/Scopus increased about 2 times. Moreover, 95 journals are included in the first (Q1) or second (Q2) quartiles.

The analysis of dissertations defenses dynamics by the expert council of the Higher Attestation Commission "Control, Computer Engineering and Computer Science" on the example of specialty 05.13.18 "Mathematical modeling, numerical methods and program complexes" is carried out. These dissertations are substantially based on articles indexed by WoS/Scopus, and the proportion of such articles is about 50 percent with a fairly even distribution across regions.

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