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Tuning national performance-based science policy: introducing fractional count

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Introduction

Since 2012, the scientometric-centric (or performance-based) science policy has been finally approved in Russia. In May 2012, President of Russia V.V. Putin proclaimed that the fraction of Russian research publications indexed by Web of Science in 2015 has to be greater than 2.44 %. At that time, scientometric KPIs had already appeared in various official documents, but it was this decision that became the "point of no return" from the trajectory of a new science policy based on quantitative indicators. In 2018, a commitment to the performance-based science policy was confirmed at the highest state level. The new Decree of the President of the Russian Federation sets the task to take the 5th place in the world in the number of scientific publications by 2024 (in fact, this means a doubling of this number).

In the previous research, we introduced the principles of performance evaluation of Russian scientific organizations (*Kosyakov & Guskov*, 2019). However, an attempt to evaluate the universities with quantitative methods is failing. Among the reasons are: poor data quality (reports from institutions with aggregated indicators are used), lack of well-established mechanisms for data analysis and verification (there is no connection with primary data in citation indices), as well as conscious and unconscious manipulations (associated with the inability to determine the real involvement degree of the institution specified in the author affiliation in the preparation of a scientific publication).

Another significant problem is the phenomenon of synchronous mobility – simultaneously holding scientific positions in different institutions *(Markova, Shmatko & Katchanov, 2016).* Due to the relatively low wages of scientists and teachers since the 1990s and other historical reasons, the practice of combining positions has been developed, when one person is simultaneously an employee of the university (educational activity) and of the scientific institute (scientific activity). This creates the prerequisites for designation both affiliations in their publications, regardless of the real contribution.

Thus, in the existing situation, conditions are created for systemic distortion and formation of false assumptions in the scientific community. The science policy requires adjustment to encourage the conscientious contribution of each researcher and institution to the target indicator – the number of publications indexed in the WoS or Scopus.

This work is devoted to the study of the method of fractional count of publications in the process of national-level research assessment, which allows to reduce these negative effects. A systematic review of the methods of fractional count of publications was performed by (Egghe, Rousseau & Hooydonk, 2000), the advantages of the fractional count were shown in (Huang, Lin, & Chen, 2011).

Method

To conduct the study, data on publications with at least one Russian affiliation from 2000 to 2018 was downloaded from the Scopus (900,000 records). The indicators of the publication activity dynamics of the leading Russian scientific institutions and universities was carried out in three ways:

- PS_i is the number of publications with at least one affiliation of the institution i,
- FS_i is the sum of fractional scores $fs_p(i) \in [0..1]$ of all publications p of the institution i, $\mathbf{fs}_p(\boldsymbol{i}) = \frac{1}{N_p}\sum_{a_j}\frac{Z(i,a_j)}{AF(a_j)}$, where a_j are authors of p; $1 \le j \le N_p$ – the number of authors; $AF(a_j)$ is the number of affiliations for author a_j, $Z(i, a_j)$ is 1 if a_j has an affiliation i, and 0 it has not. E.g., if in publication p author a_1 has affiliation i_1, $a_2 - i_2$, $a_3 - i_2$ and i_3, then $fs_p(i_1)$=1/3, $fs_p(i_2)$=1/2, $fs_p(i_3)$=1/6.
- LFS_i is the sum of the local fractional scores $lfs_p(i)$ of all publications p of the institution i, where $lfs_p(i)$ is $fs_p(i)$, from the count of which foreign affiliations are excluded. E.g., if i_2 is foreign institution, then $fs_p(i_1)=fs_p(i_3)$=1/2.

The use of fractional count makes it possible to evaluate more fairly the performance of scientific research than a whole-number count. In fact, 1-2 researchers usually spend disproportionately more effort on preparing an article than a group of 10 people or a large collaboration that publishes them in dozens and hundreds. The disadvantage of using fractional count is its laboriousness, since it requires detailed processing of the entire array with authors and affiliations, aggravated by the problems of their identification ambiguity. It can demotivate research

work in real collaborations; therefore, in the Russian context, it is most expedient to apply the LFS_i indicator to support international collaborations.

Results

This assumption is factually confirmed. Figure 1 shows that the number of publications with single-affiliated authors from 2011 to 2017 has dramatically decreased from 84.4% to 69.8%. At the same time, the number of publications with at least one multi-affiliated author has doubled. Almost 1% of Russian publications having an author that indicates more than three affiliations in one article! This creates a rather strange situation, when the indicators of individual institutions are growing much faster than overall result.

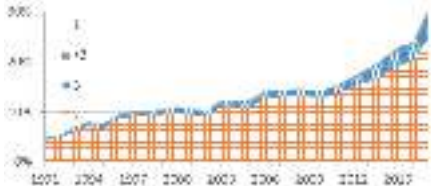

Fig. 1. Share of publications which authors have maximum one, two, three or more affiliations.

We demonstrate the results of fractional count with an example of 10 universities among the leading in the country (Fig. 2). In the transition from whole-number to fractional count, ranking varies significantly. The collaborations around these universities are very different and provide different contributions to publication activity, which discriminates institutions with weak external links. This is especially noticeable in cities where the university is the only serious scientific institution (Southern Federal University and Samara National Research University). The transition to fractional count eliminates this difference and allows to more accurately determine the "own performance".

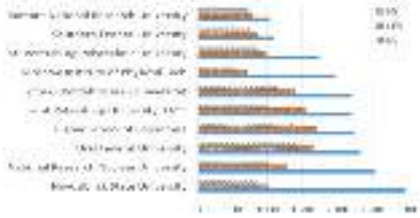

Fig. 2. Compare of PS, LFS and FS for some top Russian universities in 2017.

Let's introduce local collaboration coefficient of the institution $LCC_i \in [0;1]$, which is calculated as $LCC_i = 1 - (LFS_i / PS_i)$. If $LCC_i = 0$, the institution i does not have any common publications with other Russian institutions. If $LCC_i = 0.5$, this means that among the publications of the institution i, their affiliation contribution is equal to that of all other Russian institutions.

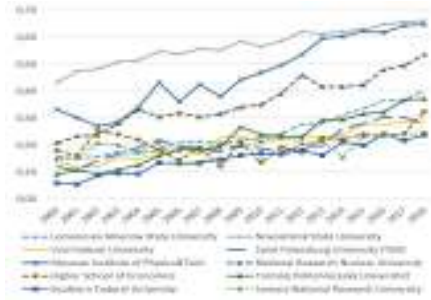

Fig. 3. Dynamics of *LLC* for some top Russian universities.

Fig. 3 shows that since 2000, the dynamics of LCC_i at leading Russian universities is increasing (level of national collaboration is growing). Since 2013, this growth becomes faster for most institutions. The analysis of the 100 most successful Russian organizations in 2017 showed that for them $LCC_i \in (0.2\text{-}0.5)$. The exception is nine universities and research centres in the field of physics ($LCC_i \in (0.6\text{-}0.8)$), which have many publications in large collaborations.

Conclusion

Research performance-based policy has led to a number of distortions. Using local fractional score ***LFS*** allows for a more fair account of the contribution of authors and organizations. Introducing such performance indicator more clearly shows the goals of national science policy for institutions and researchers. The local collaboration coefficient is a stable-in-time indicator that adequately demonstrate the share of the institution contribution to the published results.

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