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5.2.2. Математические, статистические и инструментальные методы экономики (физико-математические науки, экономические науки)

5.2.2. Mathematical, statistical and instrumental methods of economics (physical and mathematical sciences, economic sciences)

### **О МАТЕМАТИЧЕСКИХ, СТАТИСТИЧЕСКИХ И ИНСТРУМЕНТАЛЬНЫХ МЕТОДАХ ЭКОНОМИКИ И УПРАВЛЕНИЯ НАУКОЙ**

### **ABOUT MATHEMATICAL, STATISTICAL AND INSTRUMENTAL METHODS OF ECONOMY AND MANAGEMENT OF SCIENCE**

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Установлено, что для анализа проблем развития науки нет возможности опираться на данные официальной статистики. Рекомендуем использовать подходы науковедения. Кратко рассмотрены основные результаты автора в этой области исследований (1984 - 2022). В частности, было установлено, что число цитирований является ключевым показателем результативности в фундаментальной науке. С целью более глубокого изучения внутренних закономерностей развития научной деятельности начато рассмотрение динамики взаимодействия (единства и борьбы) пар противоположных начал, названных полюсами (выявлено 23 пары таких полюсов). Из математических моделей развития науки более подробно обсуждаются экспоненциальная и логистическая модели роста числа научных публикаций. Существование пределов роста приводит к выводу о предстоящей смене моделей функционирования экономики и ее важной составной части - науки. Обсуждается отрицательная роль глобализации в научной деятельности и необходимость поворота к поддержке национальной науки. Рассмотрена роль информационного барьера, который порождает систему научных кланов и стремление к автаркии в сообществе исследователей. На основе анализа баз библиометрических данных сделан вывод о нецелесообразности ориентации на западные базы WoS и Scopus и обоснования рекомендации об использовании РИНЦ. Рассмотрены достоинства и недостатки действующей версии РИНЦ. Показана польза применения законов диалектики при изучении развития науки. Закон единства и борьбы противоположностей позволил проанализировать процессы развития науки и дать рекомендации по совершенствованию инструментов управления наукой. Наличие информационного барьера соответствует закону перехода количества в качество. Закон отрицания отрицания применен для обсуждения

It has been established that for the analysis of the problems of the development of science there is no way to rely on official statistics. We recommend using scientific approaches. The main results of the author in this field of research (1984 - 2022) are briefly considered. In particular, it has been found that the number of citations is a key indicator of performance in basic science. With the aim of a deeper study of the internal laws of the development of scientific activity, consideration of the dynamics of interaction (unity and struggle) of pairs of opposite principles, called poles, has begun (23 pairs of such poles have been identified). Of the mathematical models of the development of science, the exponential and logistic models of the growth in the number of scientific publications are discussed in more detail. The existence of growth limits leads to the conclusion about the forthcoming change in the models of functioning of the economy and its important component - science. The negative role of globalization in scientific activity and the need to turn to the support of national science are discussed. The role of the information barrier, which generates a system of scientific clans and the desire for autarky in the community of researchers, is considered. Based on the analysis of bibliometric databases, it was concluded that it is inappropriate to focus on Western WoS and Scopus databases and substantiate the recommendation to use the RSCI. The advantages and disadvantages of the current version of the RSCI are considered. The benefits of applying the laws of dialectics in the study of the development of science are shown. The law of unity and struggle of opposites made it possible to analyze the processes of development of science and give recommendations for improving the tools for managing science. The presence of an information barrier corresponds to the law of the transition of quantity into quality. The law

систем распространения полученных научных результатов: от обмена письмами к рецензируемым научным журналам и затем к непосредственному размещению научных работ в Интернете. Автор настоящей статьи - один из наиболее цитируемых отечественных исследователей в математике и экономике, поэтому надеется на интерес к его размышлениям

of negation of negation is applied to discuss systems for disseminating scientific results: from the exchange of letters to peer-reviewed scientific journals and then to the direct placement of scientific papers on the Internet. The author of this article is one of the most cited domestic researchers in mathematics and economics, and therefore hopes for interest in his reflections

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## Introduction

Science and scientific service is a major branch of the national economy of Russia. However, there are some problems, for example, when determining the number of employees in this industry.

According to the Federal State Statistics Service and the National Research University Higher School of Economics The staff engaged in research and development was 682464 people in 2019, including 348221 researchers [1, pp. 20-21]. The following definitions are used:

**"R&D personnel**, - a set of persons whose creative activity, carried out on a systematic basis, is aimed at increasing and searching for new areas of application of knowledge, as well as providing direct services related to the implementation of research and development.

**Researchers-** employees professionally engaged in research and development and directly involved in the creation of new knowledge, products, processes, methods and systems, as well as the management of these activities. Researchers usually have completed higher education" [1, p.89].

As of February 3, 2022, the Russian Science Citation Index registered 641,864 authors with publications over the past 5 years. This is how many

<http://ej.kubagro.ru/2023/02/pdf/11.pdf>

people are active in research activities. Their number exceeds the data [1] (according to researchers) by 1.84 times.

Such a large discrepancy requires clarification of the reasons for its occurrence. In our opinion, the main reason is that Rosstat takes into account as researchers only persons holding scientific positions, while a significant proportion (up to 50%) of scientific publications reflects the work of the teaching staff of higher educational institutions. Simply put, Rosstat does not consider professors to be researchers, while in accordance with established practice, university administrations require them to at least 2 scientific publications per year. From what has been said, it follows that for the analysis of the problems of the development of science there is no way to rely on official statistics. For such an analysis, we will use the approaches of science of science (the science of science, the theory of science).

The article is devoted to a discussion of a number of mathematical, statistical and instrumental methods of economics and science management. The choice of topics for discussion is subjective, it is due to the experience of the author's research activities in the field of science of science.

### **On the development of science studies research**

We have been working in the field of science of science for four decades, the first publication was published in 1984 [2]. Initially, we analyzed the totality of papers presented at major scientific conferences and congresses (see, for example, [3]). This activity turned out to be very useful in preparation for the creation and then directly in the organization of the All-Union Statistical Association [4]. From the standpoint of science of science, our scientific field was analyzed - statistical methods of data analysis, urgent problems were identified, and ways to solve them were outlined. However, as a result of the collapse of the Soviet Union, the number of specialists in applied science who

developed and applied statistical methods was sharply reduced, and the All-Union Statistical Association itself ceased to exist.

The conditions that developed after 1991 were taken into account when forecasting the development of the branch of the national economy "science and scientific service" [5]. The forecast, unfortunately, came true, the state of science in the Russian Federation is currently much worse compared to the USSR in the 1980s. In particular, the number of researchers has been significantly reduced.

Then, already in the XXI century, we moved on to the problems of applying scientometrics and expert assessments in the management of science. Our team of several dozen specialists analyzed various problems in this area and approaches to their solution, the results of these works are presented in the collection [6]. At this stage of research, we focused on justifying the fact that the number of citations is a key performance indicator in fundamental science (see, for example, monograph [7] and article [8]). This statement seems almost trivial - the more often a researcher's scientific publications are cited, the more more than his contribution to the development of science as an information process. However, we observe attempts to refute this statement (see, for example, [9]).

For the purpose of a deeper study of the internal laws of the development of scientific activity, we began to consider the dynamics of interaction (unity and struggle) of pairs of opposite principles, called poles. We have identified 23 pairs of such poles [10, 11].

In 2021, our scientific team launched the Biocosmological Initiative [12]. We began to consider the development of science on the basis of this approach [13]. In the joint work [14], a number of results in this direction were obtained.

The most relevant of our scientific results in the field of science of science are considered in this article. For the convenience of the reader, we avoid additional references to the above articles and books [2 - 8, 10 - 14].

It should be noted that according to the Russian Science Citation Index, the contribution to science of the author of this article is more than 7.65 times greater than that of the current president of the Russian Academy of Sciences (estimated by the number of citations - 17413 and 2276, respectively, as of 01/03/2023). This is explained by the fact that the members of the Russian Academy of Sciences, when electing the president, proceeded from the priority of having the qualities of an effective manager, and not from the achieved scientific results. The author is the most cited researcher at Moscow State Technical University. N.E. Bauman, according to the number of citations, he is among the ten most cited domestic researchers (on the topics "Mathematics" and "Economics. Economic Sciences"). These facts give the author of this article grounds for discussing the problems of managing science at the present stage.

### **Mathematical models of the development of science**

Fundamental science has demonstrated its applied value by ensuring the creation of nuclear weapons. The governments of the leading countries realized the importance of fundamental science after the nuclear strikes on Hiroshima and Nagasaki in 1945. As a result, in the middle of the twentieth century, science developed without external restrictions. Simply put, the funding of scientific research was carried out in accordance with the requests of scientists [15 - 17].

As V.V. Nalimov [18], in the absence of external limiting factors, each scientific work generates a certain number of new scientific publications. To clarify the main trends in the development of fundamental science, one can use a sketch model (in the sense disclosed in [19]). Let  $y = y(t)$  - number of publications at time  $t$ . Then

$$\frac{dy}{dt} = ky, (1)$$

where the coefficient  $k > 0$  corresponds to the response to publications in the area of knowledge under consideration (on average). Thus, the rate of growth in

the number of publications is proportional to the level already reached, i.e. each publication generates  $k$  new ones in the next moment of time. The origin relationship is captured as a citation. Equation (1) corresponds to unlimited free growth.

As is known, the solution of the differential equation (1) is the exponential function

$$y = y(t) = A \exp(kt), (2)$$

where  $A$  is a positive coefficient. In the absence of external restrictions, exhibitors of type (2) describe not only the growth in the number of publications, but also the dynamics of other indicators of the national economy sector" - the number of researchers, the amount of funding, etc.

However, for the development of science, as well as for the development of the economy as a whole, there are limits to growth, in particular, determined by the limited resources of the globe. In the article [20], we found that the expanded reproduction model leads to an exponential growth of macroeconomic indicators. Growth limits prevent this. Consequently, the modern economic model corresponds only to some limited period in the life of mankind. Important changes are coming. In particular, after some time, the growth of the gross domestic product (both individual countries and the Earth as a whole) should be replaced by its stagnation or even decrease.

A similar fate awaits science. Due to well-known historical reasons, the reduction in the total indicators of scientific activity began in Russia earlier than in other countries. In our country, the branch of the national economy "science and scientific service" has decreased significantly since 1990. The current situation is fundamentally different from the past period of exponential growth in the mid-twentieth century. The manifold consequences of this change in the position of science have yet to be comprehended.

Let us only note the increase in the proportion of older scientists (aging of scientific teams), the lack of a basis for growth due to the "demographic failure",

i.e. a sharp reduction in the number of young and middle-aged scientists compared to the middle of the 20th century. Many achieved scientific results will simply have no one to develop. Some directions will cease to grow, just as elementary geometry has "frozen" at the present time. It can be stated that the next generations will master and apply basically only what is included in the textbooks. Therefore, the principle "Education - through science" is so important, which underlies the educational activities, for example, of the Moscow State Technical University. N.E. Bauman. The point is that the latest scientific results should be included in the training courses.

In the presence of growth limits, it is natural to assume that for the function under study  $y(t)$  there is a maximum possible value of  $b$ . Then instead of (1) it is natural to consider the differential equation

$$\frac{dy}{dt} = ky(b - y). (3)$$

Equation (3) describes growth retardation because the relative growth rate

$$\frac{1}{y} \frac{dy}{dt} = k(b - y). (4)$$

decreases monotonically. The solution of the differential equation (3) is the logistic dependence

$$y = y(t) = \frac{b}{1 + A \exp(-kbt)}. (5)$$

According to (5), the value of the function  $y(t)$  increases monotonically, but always does not exceed  $b$  and tends from below to this upper limit as  $t$  grows without limit. As noted in [21], one of the main reasons for the decline in the effectiveness of scientific work is the irrational distribution of resources.

Relations (1) - (5) provide an ideological basis for in-depth statistical analysis of scientometric data [18]. Numerous publications are devoted to mathematical methods of economics and management of science (see, for example, [22, 23]). Research is carried out on the basis of various models - mathematical, verbal, graphic. The scientific direction "Economics and knowledge management in corporate and regional socio-economic systems" is

actively developing. Modern technologies for managing innovative ecosystems” of the Kuban State University [24].

### **Globalization and Science**

How do world science and national sciences compare? Let's discuss the problem of their relationship. Naturally, the main attention is paid to the problems of domestic science.

There is no need to dwell on the disclosure of the concept of globalization here. For us, it is only important that the concept includes the existence of a single world science, which has priority over national sciences.

Who benefits from globalization? By now, it has become clear that it reflects only the aspirations of the Anglo-Saxons (primarily the United States and Britain). This small part of the Earth's population claims to dominate the world. However, these claims are not substantiated.

Now the most powerful country in economic terms is China. The value of a country in the world economy is usually estimated by the value of the gross domestic product, estimated by recalculation on the basis of purchasing power parity. According to this indicator, China is in first place in the world (since 2014), the United States is in second place. We expect that India will soon overtake the US, pushing this state to third place. Then the economic power will correspond to the population. The second three in terms of this indicator are Japan and Germany. Russia. They will lag behind China, India and the US both in terms of economic performance and the number of citizens.

In the modern era of change, the concept of globalization is a powerful ideological weapon of the Anglo-Saxons, which allows leveling the backlog in the economy.

As a consequence, the old understanding of globalization must be abandoned. This need has come to light in recent years, when global contacts have been drastically reduced due to the pandemic and sanctions imposed by the

West. As a result, we have to proceed from our own capabilities, in particular, to carry out import substitution.

The rejection of the concept of globalism cannot happen overnight. As you know, the development of industrial relations lags behind the development of modern digital productive forces. A similar lag is always observed for the mass consciousness. In our country, the idea of the superiority of Western production and social structures has been taking root for about 400 years, since the time of the Time of Troubles at the beginning of the 17th century. This phenomenon can be briefly called kowtowing before the West. It is worth noting that the introduction of cringing did not happen smoothly, with varying success, sometimes there was a return.

It must be noted with regret that for scientists the idea of globalization still dominates the mass consciousness of researchers. Most of them do not doubt the existence of a unified world science. Its parts are the sciences of individual countries (national sciences), but they cannot be recognized as independent. The worker of science believes that his research is carried out in order to add new knowledge primarily to world science (and not to national science). At the same time, in accordance with the accepted views on globalization, the science of the Anglo-Saxon countries is the center of world science. From these erroneous ideas it follows that the most important scientific results should be presented in English-language publications. These ideas are supported by the opinion that the support of English-speaking scientists is necessary for a high appreciation of scientific achievements. WoS and Scopus focused on Anglo-Saxon science.

Let us highlight a number of consequences of such ideas that harm the development of national sciences outside the Anglo-Saxon world. The requirement that scientific papers be published in English, and not in the national language, strikes at the prestige of the respective state. It significantly reduces the number of readers from this country, who, due to the presence of an information barrier [10], naturally prefer to get acquainted with publications in

their own language. For publication, as a rule, it is necessary to pay certain amounts to the publisher, therefore, stimulating publications in foreign publications entails the appearance of financial flows directed to foreign countries, i.e. leads to capital flight. The idea of the paramount importance of English-language publications naturally stimulates scientific contacts with representatives of the Anglo-Saxon world, as a result, leads to a reduction in such contacts with representatives of their country. This pushes to move to the Anglo-Saxon countries, i.e. to brain drain. Summing up, we state that the results of studies carried out with the financial support of the national state, i.e. ultimately the taxpayers of this state. Moreover, people leave for English-speaking countries from their native country, which has spent significant funds on their professional development. Thus, following such ideas, arising from the widespread uncritical understanding of globalization, brings significant income to the Anglo-Saxons - at the expense of national sciences. that the Anglo-Saxon countries receive as a matter of priority the results of research carried out with the financial support of the nation state, i.e. ultimately the taxpayers of this state. Moreover, people leave for English-speaking countries from their native country, which has spent significant funds on their professional development. Thus, following such ideas, arising from the widespread uncritical understanding of globalization, brings significant income to the Anglo-Saxons - at the expense of national sciences. that the Anglo-Saxon countries receive as a matter of priority the results of research carried out with the financial support of the nation state, i.e. ultimately the taxpayers of this state. Moreover, people leave for English-speaking countries from their native country, which has spent significant funds on their professional development. Thus, following such ideas, arising from the widespread uncritical understanding of globalization, brings significant income to the Anglo-Saxons - at the expense of national sciences. who spent a lot of money on their professional development. Thus, following such ideas, arising from the widespread uncritical understanding of

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It is also important to keep in mind the widespread practice of the Anglo-Saxons to steal intellectual property. Such incorrect appropriation of other people's scientific ideas and results is usually camouflaged in various ways. Let us point out one of them, with whom we had to meet more than once. After reading an article by a Russian scientist, an American publishes his own article presenting the results of the Russian and his own minor addition to them. The article by the American is cited for further research, and the original work of the Russian scientist, in which the main basic scientific result was obtained, is no longer cited.

The greatest harm is caused by the appropriation of intellectual property for significant scientific and technological achievements. It is known that the mobile phone and the Internet were first developed and implemented in our country.<sup>1</sup> However, now they are usually perceived as the achievements of the Anglo-Saxons. Another example - the science of managing people (management) originates from the "Russian system of training in crafts" created in the 1870s at the Moscow State Technical University. N.E. Bauman (at that time it was called the Imperial Moscow Technical School) [25]. But in English-language management textbooks and their translations into Russian, it is stated that it was formed much later, already at the beginning of the 20th century, and not in Russia, but in the USA.

The most significant and independent national sciences protect themselves from such distortions by supporting the use of the languages of their countries in

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<sup>1</sup><https://orlovs.pp.ru/forum/viewtopic.php?f=2&t=2804>

the scientific sphere. For example, in the PRC, the state ensures that the vast majority of scientific results obtained in the country are published in Chinese. And in France - in French.

It must be stated that the focus on globalization hinders the development of domestic science. It is sad that, until recently, officially adopted normative acts in the field of science management valued publications in English more than those published in Russian. Namely, the work considered in WoS or Scopus brought several times more points than published in domestic sources (the mentioned points were used in the preparation of reports on scientific activities in research institutes and universities). Note that in 2022 they began to correct such distortions.

As shown above, domestic science should be a priority, not world science. In our opinion, the main scientific results should first be published in Russian publications. Such articles and books are more useful for domestic science than those published abroad, and therefore managers in the field of science should rate them higher. This does not mean that foreign research can be ignored. The study, analysis and evaluation of foreign-language publications are the responsibility of scientific organizations (for example, VINITI, INION) and specialists specially aimed at such activities. The results obtained should be available to the Russian scientific community. The reverse process is also important - bringing the results of domestic work to the structures of world science. Detailed recommendations for such work are given in the article by Prof. D.S. Shmerling in the collection [6].

There is no doubt that the system of management of scientific activity should be aimed at the development of domestic science, acting for the benefit of our country. This requirement is most natural for applied scientific research. It should be noted that when conducting fundamental scientific research, it is not always advisable to necessarily begin with a study of what has been done earlier in world science. Quite often it is possible and necessary to conduct research

"from scratch", as Academician L.D. Landau, one of those who made the greatest contribution to the physics of the twentieth century.

For example, a negative attitude towards self-citation, which deprives the reader of important information (because it hinders the development of science as an information process [17]), in particular, makes it difficult to transfer knowledge from one scientific field to another. Or the requirement for mandatory blind peer review, which noticeably slows down the publication of new results. The most famous (primarily thanks to the efforts of the media) Russian mathematician G.Ya. Perelman posted his main results on the Internet without any review.

### **Information barrier, clans and autarky**

The slowdown in the development of science is a consequence of its rapid growth. Each specific researcher in his professional life can only get acquainted with a small fraction of publications in his specialty. Let's explain on the example of a simplified calculation. If you study one article or book every week, then in a year you will be able to get acquainted with 52 publications, in 100 years - with 5.2 thousand scientific papers. Meanwhile, the Russian Science Citation Index includes works by 89,462 authors on the topic "Economics. Economic Sciences" (as of 01/04/2023). Consequently, a particular researcher can get acquainted with the works of no more than 5.8% of the authors included in the RSCI. If we take into account that the authors often publish not one article, but tens and hundreds, works by foreign scientists are published on the subject of the researcher in various languages, Moreover, new works appear constantly, it can be confidently concluded that each particular researcher can read only a fraction of a percent of the works on his subject. Therefore, we can state the general ignorance of scientific workers. This statement seems shocking, but, unfortunately, it is true in modern conditions. Ancient Greek philosophers could know the views of a friend, but this is impossible for modern scientists.

The scientific community has developed a natural method to overcome the described complexity. It was divided into separate groups, each of which operates independently of the others. We called these groups clans in previous articles. As a rule, a clan includes a relatively small group of specialists - a few hundred people. Each of the clan members is more or less familiar with the work of other clan members, but at the same time does not have sufficient information about what is being done outside the clan. Contacts with other clans are usually maintained only by clan leaders. Leaders of clans close in subject matter form a clan of a higher level in the hierarchical system of scientific clans.

Over time, the clan acquires a developed scientific infrastructure - scientific organizations and universities (or their structural subdivisions - departments, faculties), journals, conferences, dissertation councils. A developed clan is often called a scientific school. They often talk about research teams [26], including invisible ones [18].

From a mathematical point of view, we are talking about fuzzy clustering [27 - 29] of a set of specialists. A particular researcher can simultaneously belong to several clans, for example, a clan of a scientific unit (for example, a university faculty) and a clan of scientific interests (for example, a clan of specialists in statistical methods), although with different values of the membership function.

The clan system is a brake on the spread of new scientific results. Thus, in our country, new scientific results in applied statistics are traditionally published in the journal *Factory Laboratory. Diagnostics of Materials* (in the section *Mathematical Research Methods*, founded in 1962). However, it is difficult to expect that economists, sociologists, and representatives of agricultural science would study this journal of a technical nature. Consequently, new scientific results in applied statistics should be duplicated for specialists in these specific areas and using familiar examples.

One of the consequences of the development of the clan structure is a movement towards autarky, which is very pronounced in Russian science [30]. In scientific papers, there are less and less references to specialists who have achieved official marks of recognition - to Nobel laureates, members of the Russian Academy of Sciences (we will not evaluate this phenomenon). As soon as a new clan becomes stronger, its members begin to concentrate their scientific activity within it, showing little interest in the activities of other scientific centers. S. Lem drew attention to this phenomenon in his fundamental study "The sum of technology" [31]. According to his forecast, in the future, scientific life (as well as art) will be concentrated "in its own region." Indeed, if a scientific clan is localized in a certain region, then there is no need to reach the level of a country or world science. Often there is no benefit in such an output.

The development of the clan structure, combined with the bureaucratization of scientific life, leads to the degeneration of science. Researchers are busy publishing their work and are not interested in the results of members of other clans. The attitude towards participation in scientific conferences has noticeably changed. During the period of rapid growth of science, they gathered hundreds and thousands of participants, the halls were overcrowded (see, for example, [2 - 4]). Now scientists often use formal participation in conferences only for the publication of abstracts and reports, while only a few enthusiasts are present at conferences, although modern information technologies allow participation and discussions remotely.

In modern conditions, unifying ideas are of great importance, such as a new paradigm of mathematical and statistical research methods [32 - 34] and systemic fuzzy interval mathematics developed on its basis [35 - 37].

## **Scientometric and expert methods in solving problems of science management**

For centuries, the evaluation of scientific results in fundamental science obtained by a researcher or research group was carried out by an expert. This assessment was based on the subjective opinions of members of the scientific community and administrators in the field of science, acting as experts. The pros and cons of this approach have been repeatedly discussed, including by us (see, for example, [7, 8]). It is worth noting here that the author of this article published the most cited guide in our country for collecting and analyzing subjective opinions of experts [38], and therefore we state that the criticism in our works of various examinations, including those carried out in the field of science management, is based on the achievements of the national scientific school in this area.

It is important that in the post-war decades, the information barrier became an obstacle to the reasonable application of expert assessments. This concept has been discussed above.

How to overcome the information barrier? We believe that statistical methods for studying the development of science as an information process, i.e. methods of scientometrics. More than half a century ago, in 1969, the world's first book on this topic was published [18]. Already in this monograph, it was established that an objective assessment of the contribution to fundamental science of a particular researcher or scientific group is the number of citations in further scientific articles and books.

We emphasize that for the effective use of scientometric approaches, it is necessary to carefully work with large amounts of data. For this reason, scientometric research in the twentieth century. carried out only infrequently. Therefore, it is quite natural that scientometrics began to be used to prepare managerial decisions only in XXI century, modern information and communication technologies that allow using big data analysis methods to track

all Internet resources with scientific books and articles available in the world or country.

Scientometric methods make it possible to evaluate the contribution of scientists and research groups "according to the Hamburg score". Obviously, such an assessment does not depend on the subjective opinions of the heads of scientific structures acting as experts. Realizing this circumstance, administrators in the field of science began to widely use scientometric indicators in the preparation and adoption of managerial decisions. As expected, the use of scientometrics was objected primarily to by those quite numerous scientists for whom the usual high assessment of the clan environment and higher managers contradicted the relatively low scientometric indicators.

### **About Bibliometric Databases**

Reasonable use of scientometric indicators is hampered by objective difficulties. They are generated by limitations of bibliometric databases. Unfortunately, in the widely advertised globalist Western bases WoS and Scopus, there is only a very small part of domestic publications. The reason is discrimination in the selection of journals for indexing. It leads to the fact that the contribution to science of the Anglo-Saxons is overestimated, and the Russians are underestimated, and by an order of magnitude [7].

In order to obtain an objective assessment of the effectiveness of scientific activity in our country, it is necessary to use domestic databases. The main among such systems is the RSCI. It operates on the basis of the largest Russian information and analytical portal eLIBRARY.RU, which, undoubtedly, "is the largest Russian information and analytical portal in the field of science, technology, medicine and education" (a phrase from the RSCI homepage).

However, both the RSCI and eLIBRARY.RU has a number of shortcomings. First of all, we point out that not all publications of domestic authors are included in the RSCI. For example, out of hundreds of publications

of the international journal "Biocosmology - neo-Aristotelism" (published in Russia, in Veliky Novgorod), only 6 articles are included in eLIBRARY.RU, while there is not a single one in the RSCI. Another example is one of the oldest domestic journals, The Economist (previously, from 1924 to 1990, it was published under the name Planned Economy and was one of the country's main economic journals). Out of more than a thousand articles published in this journal, eLIBRARY.RU has only 27 articles, none of them in the RSCI. Further, of all the publications included in the electronic library, only a part is considered in the RSCI. Further, among the articles and books included in the RSCI, the most important are selected and placed in the "core of the RSCI". The decision on the location of the scientific work is determined by a commission of experts unknown to us. The composition of this commission is determined without taking into account the opinions of the most productive scientists. therefore, the decisions taken cannot be considered justified.

A detailed discussion of the use of various scientometric and expert methods in solving problems of science management is devoted to our numerous publications on science of science, including those mentioned above at the beginning of the article.

### **Usefulness of Dialectics for the Study of the Dynamics of Science**

Despite the great cognitive potential of scientometric methods and expert technologies, on their basis it is possible to obtain only a rather superficial idea of the dynamics of scientific activity. For a deeper study of the development of science, it is necessary to use other intellectual tools. We consider it fruitful to rely on the laws of dialectical development in the socio-economic field. Starting from the work of 2021, we are making efforts in this direction.

The laws of dialectics made it possible to obtain new scientific results in the field of science of science. Let's talk about it briefly. We have identified 23 pairs of opposites, which we call poles. The law of unity and struggle of

opposites made it possible to analyze the processes of development of science and give recommendations for improving the tools for managing science. Since rather voluminous texts are needed to analyze the dynamics of the poles, we suggest referring to the articles [10, 11, 13].

The fundamentally important phenomenon revealed by us—presence of an information barrier—corresponds to the law of dialectics about the transition of quantity into quality. Namely, as a result of the exponential growth in the number of scientific publications, we are faced with a paradoxical phenomenon - the researcher is not able to at least look through the bulk of articles and books on his subject.

Let us discuss how information about new achievements was disseminated at different times. As you know, when science was just beginning to develop, scientists sent letters to their colleagues to disseminate their scientific results. The dialectical rejection of this way of disseminating information is the creation of peer-reviewed scientific journals. The very fact of publication in such a publication means recognition by the scientific community and allows you to secure your priority (your copyright). Now it's time for the denial of the denial. Instead of publishing in scientific journals, researchers directly post materials on the Internet. At the same time, they deny the unproductive participation of editors and reviewers. We observe a pronounced tendency to return to the system of dissemination of scientific information, invented at the initial stages of the development of science, but at a new level - with the use of modern information and communication technologies. In the near future, we can expect a refusal to publish specialized journals and the publication of scientific books as a result of the transition of scientists to the direct placement of scientific papers on the Internet. This will be a return (at the modern level) to the system of dissemination of scientific results during the exchange of letters between scientists, as was customary before the advent of scientific journals. (As you know, the history of scientific journals dates back to

1665, when the French Journal des sçavans and the English Philosophical Transactions of the Royal Society first began to systematically publish research results) In the near future, we can expect a refusal to publish specialized journals and the publication of scientific books as a result of the transition of scientists to the direct placement of scientific papers on the Internet. This will be a return (at the modern level) to the system of dissemination of scientific results during the exchange of letters between scientists, as was customary before the advent of scientific journals. (As you know, the history of scientific journals dates back to 1665, when the French Journal des sçavans and the English Philosophical Transactions of the Royal Society first began to systematically publish research results) In the near future, we can expect a refusal to publish specialized journals and the publication of scientific books as a result of the transition of scientists to the direct placement of scientific papers on the Internet. This will be a return (at the modern level) to the system of dissemination of scientific results during the exchange of letters between scientists, as was customary before the advent of scientific journals. (As you know, the history of scientific journals dates back to 1665, when the French Journal des sçavans and the English Philosophical Transactions of the Royal Society first began to systematically publish research results)

### **Conclusion**

This article briefly reviews the main results of the author in the field of science of science. For a more detailed presentation, we refer to the cited publications.

Since the contribution to fundamental science is measured by the number of citations of the researcher's papers [18], the author of this article is one of those domestic scientists who made the greatest (among his contemporaries) contribution to such scientific fields as mathematics and economics. As a consequence, I hope that this article will be of interest to readers.

Obviously, it is necessary to continue studying the development of science in order to develop the most effective management methods in this area. This work is devoted to some promising areas of such research.

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