Developing and Testing the Forecasting Algorithm for the Technological Revolution Theme through the Analysis of the SCImago JR Scientific Journal Database

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Abstract--- The algorithm applied to forecast the next technological revolution's trends has been studied and tested in this work. For this purpose, using the suggested algorithm, the bibliometric database of the 1999 and 2018 SCImago JR journals has been properly analyzed. It has been shown that the journals No. 2,000 – 10,000 (while the total amount of those journals was17.2 thousand in 1999 and 32 thousand in 2018) make the main contribution to the theme relevance in the SJR rating per their weight according to the Hirsch index and number. In terms of importance, biomedical themes were leading (44.3 %). In 2018, they included such sciences as medicine (25.5 %), genetics (7.3 %), psychiatry (4 %), neuro sciences (2.7 %), agro-bio, and nutrition sciences (4.8 %). In 2018, 34.5 % of such journals were dedicated to technical sciences. In terms of importance, 8.3 % of them referred to computer sciences. However, their maximum referred to the SJR journals no. 5,000 – 20,000, which did not characterize these scientific areas as the leading ones. In general, having analyzed the titles of scientific and technical works, it can be noted that the key areas include the sciences aimed at the growth of human capital: healthcare, education, sociology, etc. The revolutionary technological breakthroughs are most likely in such areas.

Keywords--- Technological Revolutions, Human Capital, Economic Performance, Evolution, Industry 4.0, Megatrend, Science, Innovation, Education.

I. Introduction

The modern world is at the cusp of a new technological revolution [Silberglitt, 2006; Schwab, 2017; Idrisov, 2018], but its nature is under active discussion. According to the Global Technology Revolution 2020forecast [Silberglitt, 2006] published by the RAND Corporation in 2006, the expected revolution will be interdisciplinary and will be based on biological, information and Nano technologies. Sixteen of the most practical and commercially useful technologies, including five related to biomedical, six – to information, and five – to environment, energy and housing, have been selected as the main trends. Now, at the beginning of 2020, these areas seem not to have been revolutionized, except for the introduction of genetically modified organisms and the widespread wireless communications and mobile computers considered as the global revolution.

The modern era is peculiar by the fact that human capital accounts for up to 80 % of the national wealth of all developed and largest developing countries [Korchagin, 2005; Koritsky, 2013]. Therefore, the active training of specialists in new fields is of great importance for the successful technological revolution [Luksha, 2014]. The demand for the workers who have not been essentially retrained will decrease sharply and the problem of their employment will become very acute. This makes it necessary for educational institutions [Borisov, 2000] to monitor closely the prospects for changing the labor market needs.

However, in order to determine these prospects, it is necessary to have adequate forecasting tools. The RAND Corporation is one of the leaders in developing and using forecasting technologies, but even it failed to properly forecast the latest technological revolution. Perhaps, it was because the RAND Corporation applied the Foresight method aimed at identifying several progressive technological areas and creating proper conditions [Becker, 2003; Ladykova, 2015].

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Therefore, there appears a problem about how to create the forecasting algorithm (method) to determine the technological revolution trends properly. For the moment, a great number of forecasting methods and techniques have been developed, and it is hardly required to find any conceptually new options. However, it is necessary to choose a set of algorithms and methods that are adequate to forecasting the technological revolution, improve and adapt them to the structure (model) of the selected databases, and test the min the real circumstances.

The technological revolution is a single synergistic process of realizing the accumulated knowledge, technologies, and actualized needs of humankind implemented through overcoming the crisis of the previous technological era [Pereslegin, 2009]. The identification of discrete technological trends, to which the Foresight method is aimed at, is unlikely to cause the understanding of the unified vision of the revolution.

This work aims at developing and testing the algorithm applied to forecast the next technological revolution's trends and to create the basis for forecasting the demand for specialists in new fields.

This work is conceptually based on the vision that the technological revolution is a process, primarily occurring in the field of knowledge creation, rather than the commercialization of innovations [Orekhov, 2015]. The introduction of innovations becomes more important only in the second stage of such a revolution.

However, the experience of the previous technological revolutions shows that something new makes its way by denying the previous things and does not continue them. According to Sergei Pereslegin, "... the main content of the current historical era is the crisis of the industrial civilization. This crisis is systemic and will inevitably dismount the modern industrial civilization" [Pereslegin, 2009].

However, it is possible to become conserved in a crisis, and the unclear world development after the 2008 crisis is a symptom of the fact that the contradictions between Industry 3.0 and the emerging technology cannot be resolved. This is what makes this work especially relevant.

II. Literature Review

2.1. Forecasting the Content of the Technological Revolutions

In his work The Third Wave published in 1981, Alvin Toffler, an American sociologist, proclaimed the transition to the third technological revolution. In his opinion, the economic framework of the third technological era would include electronics, computer technologies, space industry, as well as aquatic technologies and bio industry [Toffler, 1981].

Jeremy Rifkin, an American economist, philosopher, and ecologist, notes the following: "… in July 2008, the global economy stopped. This economic shock declared the end of the era of fossil fuels" [Rifkin, 2011]. According to Rifkin, it is possible to form the third economic era based on communication and energy infrastructure.

Klaus Martin Schwab, a Swiss economist, believes that "the integration of cyber physical systems" will be the driver of the technological revolution (Industry 4.0). Klaus Schwab identifies [Schwab, 2017] three technological megatrends determined by the experts: physical, digital, and biological. The first megatrend includes unmanned vehicles, 3D printing, new materials and robotics. In the second megatrend, he identifies network platforms that make contacts and transactions between people more convenient and efficient, as well as the Internet of Things. These two megatrends make up the basis of "cyber physical" systems. K. Schwab considers the prospects of the biotechnological megatrend in fewer details.

Nikolai Dmitrievich Kondratiev was among the first to pay attention to the periodic development of the economy [Kondratiev, 1925]. His theory was developed by Joseph Schumpeter who worked out the innovative cyclical Theory of economic development [Schumpeter, 1982]. He believed that the main driving force of economic development was scientific and technological innovation [Schumpeter, 1939]. J.A. Schumpeter wrote the following: "… when any innovation is introduced into the economy, there is the so-called "whirlwind of creative destruction" that undermines the balance of the old economic system and causes the end of old technologies, obsolete organizational structures, and the emergence of new industries" [Sadovnichy, 2012].

Unlike J.A. Schumpeter and N.D. Kondratiev, such authors as K. Tateisi, V. Vinge, R. Kurzweil, S.P. Kapitsa [Tateisi, 1989; Vinge, 1993; Kurzweil, 2005; Kapitsa, 2012] and others noted that revolutionary changes in the economy occurred by accelerating in time and approaching the point of a technological singularity that corresponded to the year 2025, approximately. They also pointed to the global nature of the revolutionary changes in technologies that might occur during this period. In the work of Orekhov [Orekhov, 2015], it was shown that the periods between

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the technological revolutions were reduced due to the hyperbolic consistency related to the growth in the number of people [Foerster, 1960] and, accordingly, the volume of obvious knowledge of mankind.

In 1970, Kazuma Tateisi, the head of Omron, developed the SINIC theory. According to it, since the ancient times to the present day, there has been ten major innovative shifts in the history of mankind [SINIC, 2018]. Half a century ago, based on the analysis of the logistic curves of various technologies growth, he predicted the beginning of the technological revolution that, to his mind, would be biotechnological and would begin in 2005. The 2008 economic crisis with high accuracy took place precisely at this time. J. Attali also noted ten innovative shifts during the new era [Attali, 2014] that occurred as market relations developed and accelerated over time.

However, as the variety of forecasts show, the content of the next revolution is still not clear, and there is a lack of scientifically based conclusions on this matter. At the same time, the countries that are sure to determine the vector of future technological changes will have a huge competitive advantage and the opportunity to break ahead in their development. The benefit will cost tens of trillions of US dollars.

2.2. Review of Forecasting Methods and Technologies

The forerunner of forecasting methods included various types of fantastic works and utopias [Bestuzhev-Lada, 2002]. For now, this approach is implemented through brainstorming or other methods of searching and selecting unusual solutions [Gordon, 1961; Zwicky, 1969; Shchedrovitsky, 1983; De Bono, 1997; Altshuller, 1986].

Another source of forecasting includes mathematical methods of extrapolation that are especially useful when it comes to the identified long-term consistencies and factors of the order of magnitude. To use such methods efficiently, it is necessary to obtain access to related large and long-term data [Turchin, 2013].

However, quantitative methods are used in a rather limited manner. Therefore, the forecasting experts have often started to apply qualitative methods based on surveying the qualified experts, coordination and processing of their opinions [Dagaev, 2006]. The Long-Range Forecasting Study report prepared by the RAND Corporation in 1964, which became widely known worldwide afterward, was important in ensuring the transition to a new methodological paradigm of forecasting [Gordon, 1964].

The first method brought by the RAND Corporation to the level of technology was the Delphi method, based on the iterative coordination of the opinions of a large number of experts [Pereslegin, 2009]. Another forecasting technology developed by the RAND Corporation is the Foresight. This approach differs from most forecasting methods by its focus on the implementation of certain projects. This is a method of changing the future [Turchin, 2013]. In general, the Foresight is at the junction of forecasting and planning methods.

Among the modern forecasting methods, it is necessary to mention the cognitive method of modeling offered by R. Axelrod [Axelrod, 1976]. It combines qualitative and quantitative approaches [Kosko, 1986; Kulinich, 2010; Podvesovsky, 2007]. Due to this, it is possible to define the conduct of a complex, weakly structured system with thousands of interconnections whose interaction cannot be realized by human consciousness and even groups of experts. The scenario approach developed by Hermann Kahn is an important modern forecasting algorithm [Kahn, 1976; Cornish, 2005].

One of the main problems of forecasts is the possibility of a “bubble” of high expectations – the hype cycle [Gartner, 2019] that can cause the growth in investments in the technology sector, and then the disappointment from unjustified commercial and social results.

When forecasting any technological revolutions, it is important to see a real start of the industrial shift that has matured to the stage of readiness to change essentially the world's development against the background of conflicting forecasts and predictions by deeply involved subjects representing the passing era. Therefore, forecasts require a serious information basis.

III. Methods

3.1. Main Project Parameters

The first stage of the study on forecasting a technological revolution is to determine the main parameters of the project properly [Bestuzhev-Lada, 2002]. They are presented below.

1. The purpose of the study is specified above.
2. The partyinterested in the project is the global business community and, first of all, Russia.

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3. The object of the forecast is the scientific and technical activity in the context of the developed informational and cybernetic era.
4. The subject of the forecast is the area of development because of the scientific and technological revolution.
5. The scope of the forecast is global.
6. The problem situation is the availability of conditions for the technological revolution that for more than a decade have not determined the area of the revolution and have not activated the development of the world economy.
7. The cost of error in defining a revolution for the world economy is tens of trillions of US dollars, while it is much less for Russia, plus the losses in the country's competitiveness.
8. The forecasting period (prospectus) is medium-term (10 – 20 years). The medium-term horizon makes it possible to use quantitative forecasting methods.
9. The project is focused on the search forecasting.
10. The type of the forecast is qualitative-quantitative.
11. The database for forecasting includes the SCImago Journal & Country Rank bibliometric database [SCImago, 2019].
12. Retrospectioncovers 19 years (from 1999 to 2018); it corresponds to the duration of the prospectus.
13. The novelty has a specifying nature. The preliminary model and forecast were published by the authors [Orekhov, 2015].
14. The initial hypotheses, the provisions substantiated in the work [Orekhov, 2015] include the following:

- Technological revolutions occur because of the accumulation of scientific and technological knowledge above the level that is characteristic of the previous revolution, about 1.4 times.
- Such revolutions follow in pairs that are close in direction (in the dimension of Kondratiev's long waves), the first of which sets the innovation vector, while the second one converts the resulting technological development into the economic growth.
- The cybernetic revolution has already passed two peaks; the first of which is associated with the creation of microchips and supercomputers after 1960, and the second one took place around 1990 and caused easy access to personal computers, mobile communications, etc. by most of the world's population.
- In the past, most technological revolutions had a relatively narrow specific focus. Therefore, it is undesirable to suggest several areas as new candidates.

15. The candidates for the role of a potential leader in the technological revolution are cyberphysical field, biotechnology, NBIC (nano, bio, info, cognitive), energy, and environment.
16. The algorithm for determining the leading directions of a potential technological revolution is as follows. The mathematical analysis of the SCImago JR bibliometric database makes it possible to determine the number of journals of various subjects, and therefore, the growth of knowledge in various areas. It is also necessary to take into account the relevance of journals for the scientific community.
17. The model of the object under study. The scientific and technical activities are presented in the database of SCImago JR scientific journals. It includes such indicators as "subject areas" and "subject categories", as well as the detailed information on the categories of scientific articles accepted in each journal, the names of journals, and other characteristics [SCImago, 2019]. Many journals are assigned to several categories where they have a recognized quartile. These may be the categories from various subject areas. As a result, in 2018, the total number of journals in SCImago JR was 31,971; the number of journals assigned to 27 subject areas was 52,825, and there were 73,996 publications in 309 categories. Thus, assigning a publication to a specific subject area or a subject category is not self-evident.

In order to determine the potential direction of technological revolutions, it is reasonable to reduce the diversity of the number of subject areas. The fields of knowledge presented in SCImago JR can be reduced from 27 to 15 in terms of the problem under study [Mosher, 2011; Grinin 2018], in particular, by grouping medical disciplines, as well as the areas related to economics, business and management, etc.

3.2. Algorithm for the Full Database Analysis

Since the classification of the journals into areas and categories is not explicit and does not take into account the "weight" of the journals, the complete database will be analyzed. The journal number J in the SCImago JR database corresponds to its rating and has a certain numerical value. Since the total number of journals is large, in 2018 their number was $\Sigma J = 31{,}971$, the subjects of the journals were analyzed in blocks (samples) consisting of 300 journals. In this work, nine main samples were used. They differed 1.5 – 2 times (Table 1). For each sample, the arithmetic mean fraction (frequency) of journals of various subjects in the sample was determined.

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The characteristics of each sample with the number I were expanded to the middle of the interval to the neighboring sample on the left and right. Then the number NI and the share of journals DI entering this zone of impact were determined. The characteristics of the samples and zones of influence for the 2018 journals are shown in Table 1.

Table 1: Characteristics of the Samples and Zones of Their Influence, 2018

Sample No. *I*	1	2	3	4	5	6	7	8	9	10	11
Number of the first journal from the sample, thousand	0	0	0	0.5	1.0	2.0	5.0	10.0	15.0	20.0	30.0
The average valueof the journal from the sample, thousand	0.025	0.05	0.15	0.65	1.15	2.15	5.15	10.15	15.15	20.15	30.15
Lower limit of the influence zone, thousand	0	0	0	0.4	0.9	1.65	3.65	7.65	12.65	17.65	25.15
Upper limit of the influence zone, thousand	0.05	0.10	0.40	0.90	1.65	3.65	7.65	12.65	17.65	25.15	31.97
Influence zone size – N_I, thousand	0.05	0.1	0.4	0.5	0.75	2.0	4.0	5.0	5.0	7.5	6.82
The share of journals in the zone of influence – D_I, %	0.16	0.31	1.25	1.56	2.35	6.26	12.5	15.6	15.6	23.5	21.3

Although journal number J in the SCImago JR database corresponds to its rating value, it is more convenient to use the Hirsch index H, which like individual Hirsch indexes is equal to the number of publications with a certain number of links as a characteristic of the significance of the journals. The share of the sample, taking into account the weight of the journals according to the Hirsch index XI, was defined according to formula (1), where NI was the number of journals that fell into the influence zone of the sample, and HIwas the arithmetic mean of the Hirsch index on the sample.

$$\mathbf{X_I = H_I \bullet N_I / \Sigma H_I \bullet N_I} \qquad (1)$$

Fig. 1 shows the graph of weights of XI various samples in percentage, depending on the average value of the number of journals in the 2018 sample.

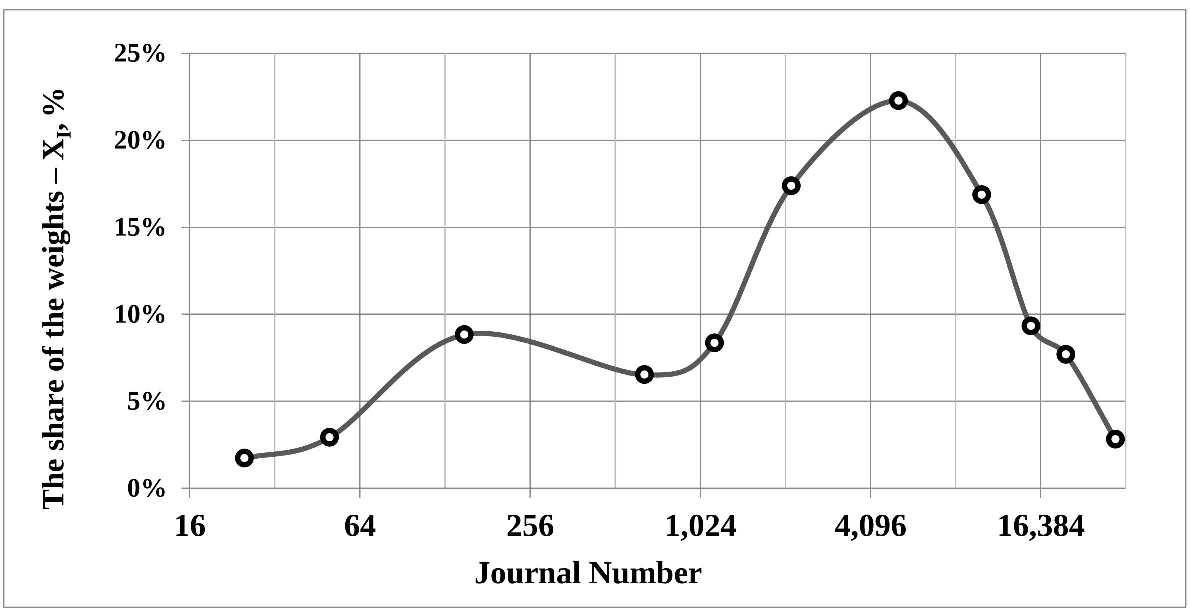

Fig. 1: Weights of Various Samples depending on the SCImago JR Number

It is possible to see that under the used set of samples, the journals in the field of influence of samples No.2,000 – 10,000 (56 %)have the highest contributions. Another indicator of the quality of the journals is the quartile. In the 2018 SCImago JR database, until No. 2,000, there are journals belonging mostly to the first quartile. After No. 7,000, the second quartile's journals (Q2) are dominating. By No. 16,000, most journals relate to the third quartile (Q3). After No. 20,000, the fourth quartile (Q4) dominates.

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IV. Results

4.1. Subject Areas of Journals

Figure 2 shows the distribution of the journals by subject areas compressed from 27 to 15 as presented above. One can see that the largest number of journals is related to medicine and associated subjects – 19.2 % in 2018. As compared to 1999, their share decreased. However, due to the increase in the number of journals, the absolute number of publications on this subject increased by about 30 %. Together with biogenetic sciences, psychology, neurosciences, bio, agro, and zoo sciences, they accounted for 31.2 % in 2018.

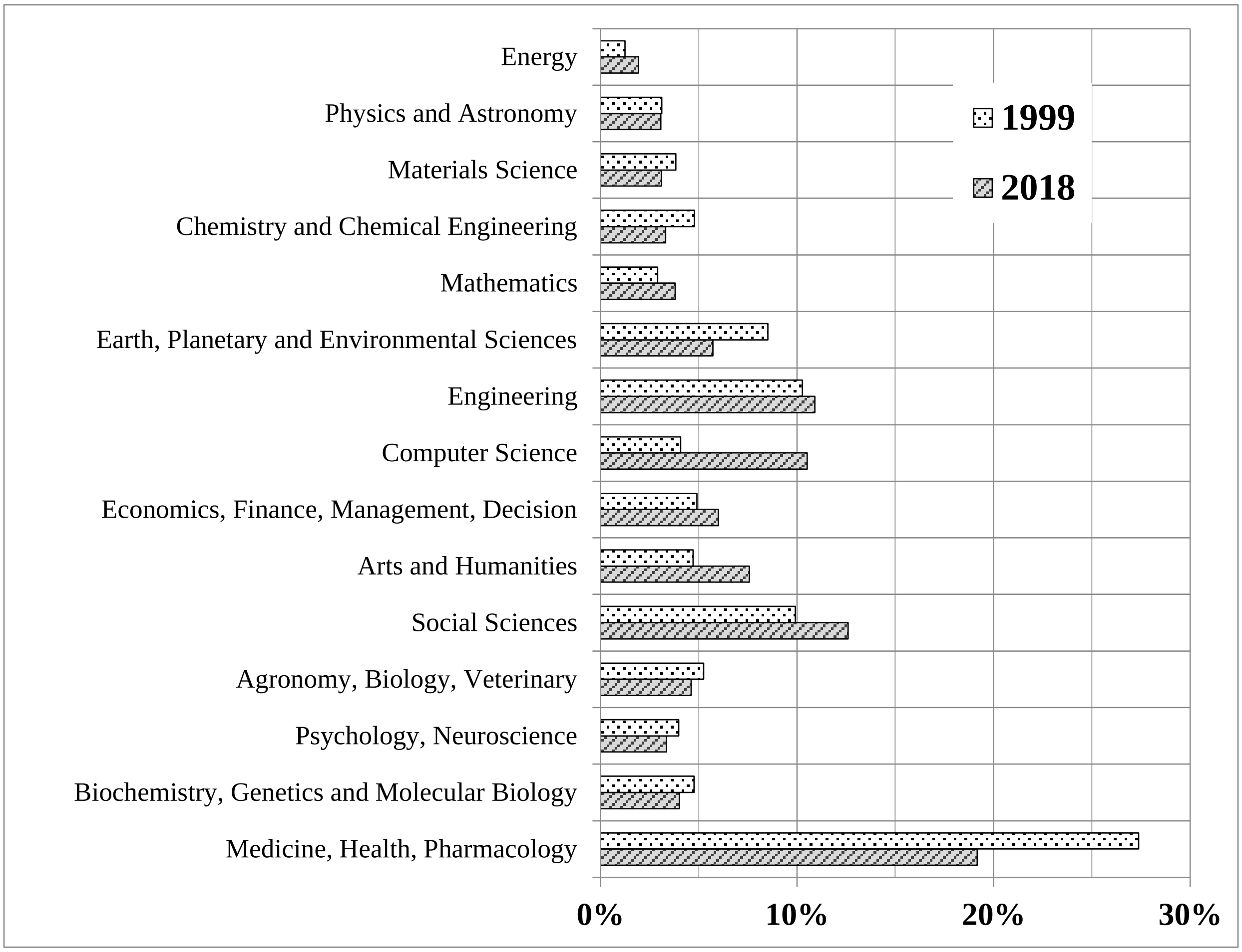

Fig. 2: The Share of Journals in Various Subject Areas

Social sciences are in the second place and make 12.6 %. Together with the humanities and art, they make 20.2 %. Their share has increased considerably since 1999. The share of economic sciences, including finance, management, marketing, strategy and decision-making, etc., had increased up to 6 % by 2018.

The computer science is represented by a relatively small share of journals to have a technological leadership – 10.5 %, but their share has more than doubled over 19 years.

Classical exact sciences like physics, astronomy, materials science, chemistry, and mathematics cover 13.3 % of the journals, which is slightly less than in 1999. The remaining fields of science, including engineering, energy, earth and planetary science, as well as the environment, but excluding computer sciences, make 18.6 % of the publications, which is also less than in 1999.

4.2. Subjects of Journals Taking into Account Their Weight

Let us further consider the distribution of the journals according to their importance and position in the SCImago JR rating. Fig. 3 shows the distribution of the shares of journals DI in the samples depending on the number of the journal in the SCImago JR rating for the biomedical subjects.

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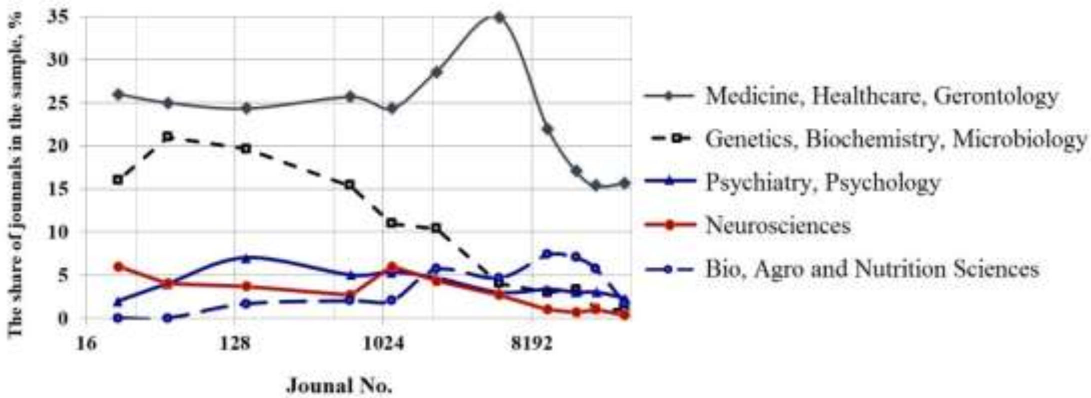

Fig. 3: Distribution of the Biomedical Journals

One can see that medical journals are leading. The high share of these publications in the first thousand means that these are advanced and innovative studies. The 5,000 peak means that traditional medical disciplines are actively developing and being widely published. A rather high share of this subject at the end of the rating corresponds to the widespread practical use of medical science.

The group of journals in biochemistry, genetics, microbiology, and associated disciplines, including the medical ones, is in the second place. Their maximum share is in the first thousand, which says that this is a highly innovative subject. A sharp decline in the share at the end of the rating means a relatively low level of practical application.

The share of neurosciences and psychiatry is about 5 % in the first thousand and decreases by the end of the rating, which shows the average level of the practical application of knowledge on this subject.

The share of neurosciences is about 4 % in the first thousand, but by the end of the rating, their share drops sharply, which indicates their small practical application.

Figure 4 shows the distribution of the share of journals (X) of biomedical subjects, taking into account their weight (1). It is possible to see that the medical subject considerably surpasses the biogenetic one, especially in the journals with large numbers, which characterizes the practical focus of the subject.

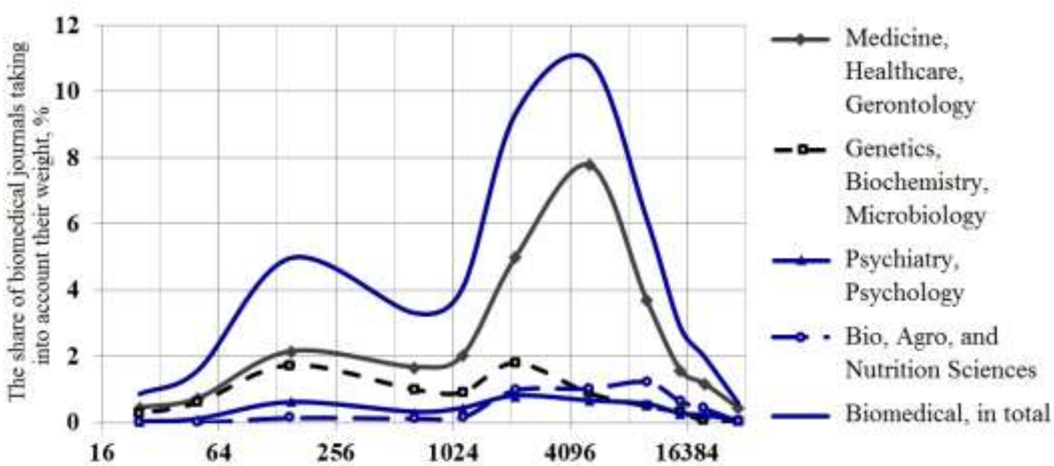

Fig. 4: The Share of Biomedical Journals Taking into Account Their Weight

In order to determine the total weight of the subjects in all journals, it is necessary to summarize its weight for all samples. In Table 2, there is a comparison of the share of journals of various subjects taking and without taking into account the weight of the samples according to formula (1), as well as their share in subject areas (Fig. 2).

It is possible to see that the consideration of the weight according to formula (1) has relatively weak impact on the average values of various subjects. However, having compared Figures 3 and 4, one can see that the significance of the first issues of the journals without taking into account the weight of the samples is considerably exaggerated.

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Table 2: The Influence of "Weight" on the Share of Journals, %

	Medicine, healthcare, gerontology	Genetics, biochemistry, microbiology	Psychiatry, psychology	Neurosciences	Bio, agro, zoo, nutrition	Biomedical, in total
The average share of journals in the sample (D), %	23.1	7.6	4.1	2.5	4.2	41.5
The share of journals taking into account their weight (X), %	25.5	7.3	4.0	2.7	4.8	44.3
The share of journals according to the subject areas, %	19	4	2.3	1.1	4.6	31.2

To detail the distribution of the journals of various key subjects, Fig. 5 shows their share (taking into account their weight).

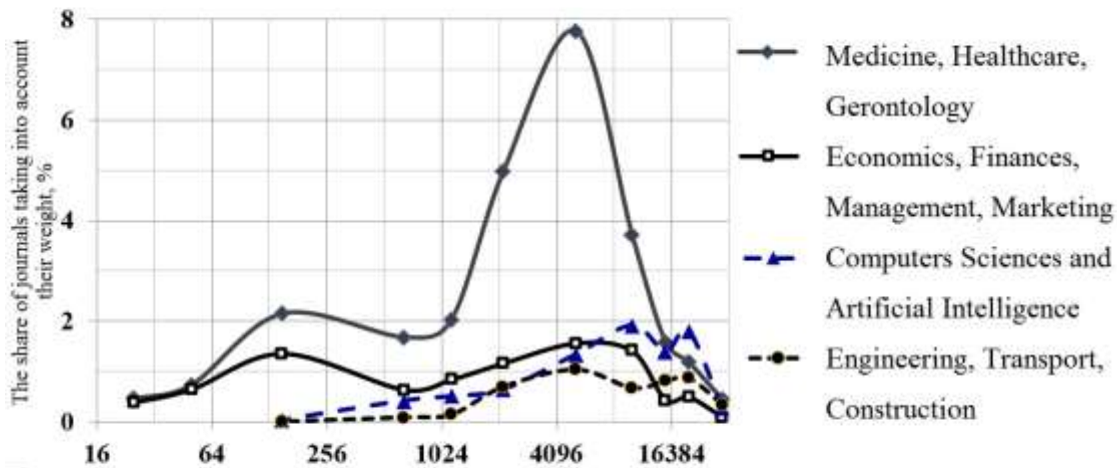

Fig. 5: The Distribution of the Share of Journals of Key Subjects Taking into Account Their Weight

In the first place, there are medical sciences. In the second place, the top-rated journals include the economic subjects. The share of publications on these subjects, taking into account their weight is about 1 % per sample.

In the third place, there are computer, cybernetic, and information sciences and publications about artificial intelligence. The first 300 journals almost do not contain them. Their maximum No. is within the 5,000 – 20,000 range, which shows that they are not ready to become a leader in the next technological revolution.

Technical sciences are even less represented, including automation, electronics, transport, construction, etc. The maximum is at the end of the rating, which corresponds to the status of the science that is widely applied in practice. The total shares of mass sciences are given in Table 3.

The indicators of a wider range of technical sciences are given in Table 4. In total, they cover about 35 % of all journals, almost as much as the biomedical ones (43 %).

The difference between the estimates for the samples of journals and the estimates for the share of subject areas is the strongest in the field of technology (engineering) and makes about 5 %.

This is probably because when assessing the journals, the sciences in the field of medical technology were related to medicine, rather than to technology. This is due to the specifics of identifying the areas of technological revolutions. Everything associated with unique medical procedures or medicines aims at improving human health, and technology is only an instrument.

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Table 3: Summary Indicators of Journals in Advanced Sciences

	Biomedical, in total	Medicine, Healthcare, Gerontology	Economics, Finances, etc.	Computer Sciences, AI	Engineering, Transport, Construction	Physics, Astronomy
The average share of journals in the sample, %	41.5	23.1	7.9	9.9	5.3	2.1
The share of journals taking into account their weight, %	44.3	25.5	8.0	8.3	4.7	2.3
The share of journals according to the subject areas, %	31.2	19	6	10.5	10.9	3.1
Maximum zone taking into account the weight, thousand	2 – 10	2 – 10	0.3 – 10	5 – 20	2 – 20	0 – 0.3; 2 – 10

Table 4: Total Indicators of Journals in Technical Sciences

Science	The average share of journals in the sample, %	The share of journals taking into account their weight, %	The share according to the subject areas, %	Maximum zone of the average share, thousand	Maximum zone taking into account the weight, thousand	Novelty
Physics, Astronomy	2.1	2.3	3.1	0 – 0.3	0 – 0.3; 2 – 10	+
Engineering	5.3	4.7	10.9	15 – 30	2 – 20	–
Computer, AI	9.9	8.3	10.5	15 – 20	5 – 20	–
Material Engineering	2.6	2.6	3.1	0 – 0.3. 10 – 15	5 – 15	
Chemistry	2.4	2.5	3.3	0 – 0.3	1 – 10	
Nanotechnologies	0.2	0.2		0 – 0.3	0 – 0.3	+
Energy	1.6	1.4	1.9	0 – 0.1; 15 – 20	10 – 20	–
Math	3.8	4.3	3.8	0.5 – 15	2 – 10	–
Geosciences	4.3	4.2	2.7	1 – 2.5; 10 – 30	1 – 15	–
Environment	2.7	2.9	3.0	0.5 – 1; 10 – 15	2 – 10	–
Multidisciplinary	1.0	1.1	0.2	0 – 0.1; 10 – 30	2 – 15	–
Total	**35.9**	**34.5**	**42.5**			

The energy is narrowly represented. Its share is about 1.5%, while that of environmental sciences – 2.8%, and that of nanotechnologies – 0.2%, although recently in Russia they have been presented as the most promising areas of the scientific and technological development [Rudensky, 2015; Danilin, 2016].

4.3. Leadership Perspectives in the Technological Revolution

Returning to the potential of new technological revolutions, let us consider the information given in Table 5. It shows the shares of publications with the weight of the main candidates for the role of a technological leader.

The biomedical area has not shown any increase in terms of the relative share of scientific journals, but their share is already extremely large. Besides, the number of journals where this area is in leading positions has

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increased by 86 %. The factor of mass and purposeful scientific work in this area can cause a breakthrough, especially because the leading biogenetic area is actively progressing.

Table 5: The Shares of Publications Taking into Account Their Weight, %

Group of Sciences	1999	2018	Relative Change, %
Number of Journals, %			
Medicine, Healthcare, Gerontology	25.4	25.5	0.4 %
Genetics, Biochemistry, Microbiology	6.8	7.3	7.4 %
Biomedical, in total	44.1	44.3	0.5 %
Computer Sciences and AI	5.4	8.3	54 %
Economic Sciences	6.7	8.0	19 %
Environment	5.2	2.9	-44 %
Energy	0.7	1.4	100 %
Sociology, Politics, etc.	3.6	5.0	39 %
Education	1.5	2.7	80 %

By itself, the biogenetic subject is not yet ready for leadership in the technological revolution because it has limited practical readiness. In general, the biomedical area is the most promising candidate to become a leader of the new technological revolution. This is also supported by the obvious demand for the improved quality and longevity of human life and willingness to pay for it.

The cybernetic (computer) sciences and artificial intelligence have a low share in the number of journals taking into account their weight (8.3 %), and their position in the rating (No.5,000 – 20,000) indicates a practical, rather than an innovative focus.

The economic sciences have a rather high (8 %) share in scientific journals. They are popular probably due to the decline in the global economic growth and forecasts of its further decrease [Hawksworth, 2006; Hawksworth, 2017]. This stimulates the search for new opportunities for economic growth, such as inclusive development [Spence, 2011]. However, economic sciences play a supporting role and cannot essentially increase economic growth.

The humanities, although their share has considerably grown, continue to remain in the group of outsiders and cannot become a leader in contemporary technological development.

The scientific share of education is relatively small (2.7 %), but the growth rate is impressive – 80 % over 19 years. The peculiarity of the socio-economic development of the humankind over the past 100 years is that the contribution of the human capital to national wealth has sharply increased. Education plays a key role in the growth of human capital [Schultz, 1963; Mincer, 1974; Barro, 2001; Kapelyushnikov, 2007; Schofer, 2006; Prichina, 2019]. Thus, education acts as an “amplifier” of human capital activity and may have considerable impact on the rate of economic development.

V. Conclusion

The results of developing and practical testing of the algorithm for forecasting the subjects of the technological revolution by analyzing the SCImago JR database of scientific journals are represented in this work.

The impact of the qualitative characteristics of the journals on the importance of key subjects of scientific development has been studied. It has been shown that the journals numbered from 2,000 to 10,000 made the main contribution to the significance of subjects, taking into account the weight according to the Hirsch index and their number.

It has been shown that the biomedical subjects are leading (44.3 %) in terms of importance. They include the following: medicine, healthcare, and gerontology (25.5 %); genetics, biochemistry, and microbiology (7.3 %); psychiatry and psychology (4 %); neurosciences (2.7 %); zoology, agricultural, and nutrition sciences (4.8 %).

Taking into account their weight, 34.5 % of the journals belong to the technical sciences (except for those included in the biomedical ones).

Among the technical sciences, in terms of importance, 8.3 % of the journals belong to computer sciences, including artificial intelligence. However, the maximum of computer sciences is referred to No. 5,000 – 20,000 of the SCImago JR rating journals, which does not make it possible to attribute this area to the leading one.

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The groups of economic (8 %), humanities (13.5 %), and educational sciences (2.7 %) are of high importance and novelty.

The substantial analysis of the directions of scientific and technological development has shown that the key areas are the sciences aimed at the growth of the human capital: medicine, education, sociology, etc. Revolutionary technological breakthroughs are most likely to happen in these fields.

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