

# Twelve Years of Access to Electronic Serials in Russia: Results and Perspectives

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## Abstract

We investigated collection development within the system of information support of research in Russia on the state-funded level. The analysis has been performed from the point of view of structure and research output of Russian science. We employed the method of bibliometric analysis using InCites by Clarivate Analytics. The results demonstrate that the state funded subscription provides more than 55% of total world output and meets about 70% of communication needs of Russian researchers in all ESI research areas. A strong correlation of informational support and research output is demonstrated.

**Keywords:** bibliometric analysis, electronic serials, collection development, library consortia, research output, readership.

## 1. Introduction

In this article we report analysis of the system of information support in Russia.

Indicators of research output such as number of publications and citations are included in national research assessment systems for instance in Australia [1], the UK [2], France [3], Italy [4] or Russia [5], and most influential world university rankings. Correlation between the indicators of research output, namely, the number of publications, times cited, share in the world

output and R&D funding was studied at the level of individual researchers [6], grant issuing organizations [7] or research-leading countries [8,9], correlation of research output and readership was reported at the level of individual documents within a single journal [10], institutional [11,12] and country [9] levels. Therefore, one can conclude that problem of information support is one of the key problems in modern research surroundings.

Libraries in academic and research institutions together with departments of research management take active part in handling and analyzing the info on research output, usage statistics, return of investments and impact of scholarly resources on the level of research and teaching. Russia is not an exception and fits world trends of development of information support [13-14]. However, being a country with emerging economy and a member of a group of BRIC countries Russia demonstrates its specific features.

After disintegration of Soviet system in the last decade of XX century, Russia met enormous problems with budget cuttings and brain drain. Finally, Russia has lost its former position among leading countries conducting research in science. In 2006, predictions for the future of Russian research output were grave [15]. In 2005, facing the problem, Russian government launched Federal Target programs aimed at improvement of level of research and education in prioritized research areas of science and technology: Life Sciences; Industry of Nanosystems; ITC Systems; Environmental Management; Energy Efficiency, Energy Saving and Nuclear Energy. From 2006 to 2014 the R&D budget in Russia was growing and in 2012 approached the one of the UK. Along with an increase in the R&D budget, additional direct funding was allocated for a group of leading Russian universities against federal projects. Today, leading Russian universities comprise: Lomonosov Moscow State University, St. Petersburg State University, 10 Federal Universities, 29 National Research Universities and 21 universities of the 5/100 project that aims at improving position of Russian universities in world university

rankings. In response to an increase in funding, research output has been growing slowly but steadily.

Within Federal Target Programs substantial budgetary funds were allocated to subscribe most important scholarly resources for Russian academics and research institutes. The System of Informational Support of Science, Education, and Culture in Russia (System of Information Support) was established at the very end of 2005 and since that time acquisition of scholarly resources has closely followed research development that was reported in 2007 [16], 2011 [17-18] and 2016 [19-20].

Specifics of Russian national system of information support is in dual funding of subscription: with the state money allocated within federal projects and programs, and the money paid by institutions from their own budgets.

***Institution budgets.*** Till 2014 the level of funding of Russian academics and research institutes was gradually growing due to direct funding. This resulted in a positive trend in library subscription, one could see that more and more money was spent on scholarly resources. Annual surveys conducted by NEICON since 2006 indicated that e-resource acquisition budgets of leading universities increased by 10 times from 2006 to 2016. However, in 2014 due to economic crisis in Russia and almost a 100% drop in purchasing power of national currency, situation changed dramatically. The 2016 and 2017 surveys showed that research and educational institutions in Russia did not have enough money to maintain information support at appropriate level [21]. In result, the number of resources subscribed with institution budgets shrunk by 38% and 80% in 2015 and 2016, respectively.

***State funding.*** Upon lasting impact of economic crisis, federal projects and programs make the only reliable sources of information support of Russian education and science. In this paper we confine our studies to national subscription projects funded by Ministry of Education and Science of Russian Federation (MES) and Russian Foundation for Basic Research (RFBR). In

2017, resources subscribed within MES and RFBR projects comprise 18 full-text journals packages provided by world leading publishers focused at STM research areas. During the whole time span of MES projects, resources have been thoroughly selected by the experts of NEICON and leading Russian libraries in result of analysis performed in Web of Science Core Collection (WoS CC) with keyword search queries built for five above-mentioned priority areas. The selection process consists of four steps described in [14, 18]: 1. Preparation and refining of search query to search for the documents relevant to a priority area (for instance, Life Sciences); 2. Search of documents in WoS CC; 3. Preparation of ranked lists of the most productive periodicals in each priority area; 4. Identification of information provider that offers those periodicals. Journal packages of world publishers that contained the largest number of articles in priority areas were subscribed.

During all years the list of resources and number of subscribers could be corrected and changed after analysis of usage statistics, cost-efficiency and ROI. Last two years, MES also takes into account resource rankings built on results of library surveys.

In [14] we reported results of assessment and quantitative estimates of the level of information support provided by MES and RFBR projects: For each priority area we calculated parameter of information support  $P$ : proportion (percentage) of articles available in subscribed resources to world research output.  $P_i = N_i / N_{i0}$ , where  $N_i$  – number of articles in  $i$  research area available via national subscription,  $N_{i0}$  – total number of articles in  $i$  research area. Results obtained in five priority areas were as follows: Life Sciences – 74 %, Industry of Nanosystems – 77%; ITC Systems – 76%; Environmental Management – 78%; Energy Efficiency, Energy Saving and Nuclear Energy – 90%. This proves a proper selection of resources in national subscription that provides a very high level of information support in the priority areas.

To fit one of the world standard classifications we extended our analysis to 22 research areas of Essential Science Indicators database. In result we got mapping of each of 18 full-text

resources in the number of articles, proportion of citations and highly cited papers and parameter of information support.

## **2. World experience in subscription and access to scientific information**

### **2.1. Principles of formation of subscription in certain research organization**

Informational support is one of the main components of research activity and the role of library is to provide necessary information with maximal efficiency. This task is quite complicated even for research organizations with limited research interests because of limited budgets being almost impossible for multidisciplinary university libraries. Situation worsens within the crisis periods: either the 2008 Global economic crisis [21,22] or Russian economic crisis of 2014 [23].

The main principles for formation of subscription are its correspondence to research areas related to the research and educational needs and high quality of resources both in content and services. There are different approaches for selection of resources to subscribe: from expert evaluation to complex bibliometric methods and their combination with expert opinion and altmetrics.

For example, journal citation analysis, journal title and core list analysis, Electronic resource analysis and OCLC's WorldShare CE tool were used to evaluate the Interdisciplinary collection and further collection development at the College of Staten Island Library [24]. WorldShare CE was also used for mapping Conspectus subject divisions and categories to relevant university departments and evaluation holdings in comparison with department metrics to provide a fuller picture for collection development decision-making [25].

A new sophisticated model for the formation of ranked lists of scientific journals for library subscription based on bibliometric analysis was proposed in [26-28]. The model is based on the search in the abstract database of a set of articles that are semantically equivalent to a set of

articles of the user or a group of users for which the repertoire of scientific periodicals is selected. In other words, the result of the request should be a collection of articles of the same thematic focus, which is expressed in the articles of the author himself. To achieve this goal, the authors used KeyWords Plus from the articles of employees of three scientific organizations in various scientific fields - biomedical, geological and physical-mathematical. KeyWords Plus, which is a brief retelling of each of the articles, is combined in the query into groups, the number of which, respectively, equaled the number of articles of employees of these organizations. As a result of the request, lists of articles were obtained exactly with the same sequences of keywords, which proved their semantic affinity. With the use of various filters, groups of journals are analyzed that concentrate the articles of interest to the greatest extent. The lists obtained are compared with the lists of journals most cited by the authors of the organizations under consideration, a considerable similarity of the lists in the field of natural sciences and a smaller one in the field of exact ones.

The last described method is quite good for choosing journals for monodisciplinary libraries. The selection of resources for multidisciplinary universities, consortium or national subscriptions must satisfy the following conditions: meeting the information needs of the maximum possible number of subscribers, as wide as possible range of scientific fields with efficient use of resources.

## **2.2. Consortium subscription**

State funded projects in Russia use consortium licenses signed by a project operator on behalf of all member-institutions. Number of consortia subscribers is different for different resources and years and have varied from two dozens to several hundred for full-text journal databases. Noteworthy is that in 2017 MES project has subscribed 1600 Russian non-commercial institutions to WoS CC. This fact grounds the choice of WoS platform for analysis performed in our study. WoS CC is the database subscribed at a true national level in Russia.

Following the widely known and well-reported international practices of library networking [29], collaborative collection development and consortia purchasing [30,31] with well established cost-effectiveness and return on investment [32-33], Russian consortia subscribe e-resources within “big deal” model when standard publisher packages of hundreds and thousands of titles are subscribed for all members of a consortium.

Big deal licenses have been negotiated by Russian national library consortium NEICON [17-18, 34] and were operated by NEICON (from 2006 to 2014) or Russian National Public Library for Science and Technology (since 2014 up to now).

Due to thorough market analysis, careful and intense negotiations with publishers, “big consortium deals” in Russia allow libraries to spend up to ten times less money compared to subscription to separate titles or selection of journals from standard packages.

After resources are subscribed, operators of MES project have monitored usage statistics, estimated cost efficiency, updated, and optimized the list of subscribed resources, number of site licenses and lists of subscribers. After several years of monitoring and optimization, cost-per-download for each of 16 resources of “ministry” subscription usually reaches reasonable values of 2-5 USD/download<sup>1</sup>. If despite all efforts, cost-per-download remains high, subscription is canceled.

One has to say that during ten years of ministry subscription, only 3 full-text resources have been canceled.

### **3. Methods**

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<sup>1</sup> We have performed our own investigation and asked international consortia and universities – members of ICOLC and publisher advisory boards to share with us criteria of appropriate price per download values referred to consortium subscriptions and got 25 responses with values varying from 0.6 to 14 USD which we cannot publish for the reason of confidentiality.

To analyze the compliance of the list of resources to be signed with the needs of Russian science we calculated the proportion of papers in subscribed resources in the overall number of documents indexed in WoS CC in last 5 years (2012-2016) together with their citation and share of documents in 10% of highly cited documents. The analysis was performed in 22 research areas used in Essential Science Indicators (ESI), so humanities appeared to be eliminated from our investigation.

We used InCites analytical instrument from Clarivate Analytics to get all the data on publications and citations. InCites accumulates publications from WoS CC (except Emerging Sources Citation Index) and permits one to obtain sophisticated bibliometric indicators for various publication sets, using either predefined filters (researchers, organizations, countries, journals, publishers, etc.), or custom data sets, exported from WoS CC. For our investigation we used filter for publishers according to the lists of imprints (Table 1).

Table 1. Publishers' imprints and journals for analysis in InCites

Publisher	Imprints
Springer-Nature	ADIS INT LTD, ASPEN LAW & BUSINESS DIV ASPEN PUBLISHERS INC, BIOMED CENTRAL LTD, BIRKHAUSER VERLAG AG, SPRINGER BIRKHAUSER, CURRENT SCIENCE LTD, SPRINGER VIEWEG-SPRINGER FACHMEDIEN WIESBADEN GMBH, VIEWEG, FRIEDRICH VIEWEG & SOHN VERLAGSGESELLSCHAFT MBH, GABLER VERLAG, GABLER VERLAG/SPRINGER FACHMEDIEN, HUMANA PRESS INC, KLUWER ACADEMIC PUBLISHERS, KLUWER ACADEMIC-HUMAN SCIENCES PRESS, KLUWER ACADEMIC/PLENUM PUBL, KLUWER ACADEMIC/PLENUM PUBLISHERS, KLUWER LAW INT, KLUWER LAW INTERNATIONAL, MACMILLAN INDIA LTD, MACMILLAN PRESS LTD, GAMSBERG MACMILLAN PUBLISHERS (PTY) LTD, PALGRAVE MACMILLAN LTD, NATURE PUBLISHING GROUP, PLENUM PRESS DIV PLENUM PUBLISHING CORP, SPRINGER/PLENUM PUBLISHERS, SPRINGER, SPRINGER BASEL AG, SPRINGER FRANCE, SPRINGER HEIDELBERG, SPRINGER IBERICA, SPRINGER INDIA, SPRINGER INT PUBLISHING AG, SPRINGER INTERNATIONAL PUBLISHING AG, SPRINGER JAPAN, SPRINGER JAPAN KK, SPRINGER LONDON LTD, SPRINGER PUBLISHING CO, SPRINGER SINGAPORE PTE LTD, SPRINGER SPEKTRUM/SPRINGER FACHMEDIEN, SPRINGER VERLAG PARIS,



	<p>SPRINGER VS/SPRINGER FACHMEDIEN, SPRINGER WIEN, SPRINGER-V D I VERLAG GMBH &amp; CO KG, SPRINGER-VERLAG BERLIN, SPRINGER-VERLAG FRANCE, SPRINGER-VERLAG ITALIA, SPRINGER-VERLAG ITALIA SRL, SPRINGER-VERLAG LONDON LTD, SPRINGER-VERLAG SINGAPORE PTE LTD, SPRINGER-VERLAG TOKYO, SPRINGER-VERLAG WIEN, CONSULTANTS BUREAU/SPRINGER, COPERNICUS AN IMPRINT OF SPRINGER, NY, MAIK NAUKA/INTERPERIODICA/SPRINGER, SPEKTRUM AKADEMISCHER VERLAG-SPRINGER-VERLAG GMBH, VIEWEG-TEUBNER VERLAG GMBH</p>
Elsevier	<p>ACADEMIC PRESS, ACADEMIC PRESS AUST, ACADEMIC PRESS INC ELSEVIER SCIENCE, ACADEMIC PRESS LTD- ELSEVIER SCIENCE LTD, ACADEMIC PRESS LTD-ELSEVIER SCIENCE LTD, BAILLIERE TINDALL, ELSEVIER BUTTERWORTH-HEINEMANN, BUTTERWORTH-HEINEMANN LTD, BUTTERWORTH-HEINEMANN AUSTRALIA, BUTTERWORTH-HEINEMANN, CELL PRESS, CHURCHILL LIVINGSTONE, CHURCHILL LIVINGSTONE INC MEDICAL PUBLISHERS, CHURCHILL LIVINGSTONE LTD, ELSEVIER DOYMA SL, EDICIONES DOYMA, EDICIONES DOYMA S A, ELSEVIER, ELSEVIER ACADEMIC PRESS INC, ELSEVIER ADVANCED TECHNOLOGY, ELSEVIER APPL SCI PUBL LTD, ELSEVIER BRAZIL, ELSEVIER ESPANA S I, ELSEVIER FRANCE- EDITIONS SCIENTIFIQUES MEDICALES ELSEVIER, ELSEVIER GMBH, URBAN &amp; FISCHER VERLAG, ELSEVIER INC, ELSEVIER INFORMACION PROFESSIONAL, S A, ELSEVIER MASSON, ELSEVIER MASSON SAS EDITEUR, ELSEVIER IRELAND LTD, ELSEVIER NORTH HOLLAND, ELSEVIER SCI LTD, ELSEVIER SCIENCE BV, ELSEVIER SCIENCE INC, ELSEVIER SCIENCE LONDON, ELSEVIER SCIENCE LTD, ELSEVIER SCIENCE PUBLISHERS BV BIOMEDICAL DIVISION, ELSEVIER SCIENCE SA, ELSEVIER SCIENTIFIC PUBL CO, ELSEVIER SCIENTIFIC PUBLISHERS IRELAND LTD, ELSEVIER SINGAPORE PTE LTD, ELSEVIER TAIWAN, ELSEVIER URBAN &amp; PARTNER SP Z O O, ELSEVIER-IRCS LTD, ELSEVIER/NORTH-HOLLAND, JAI-ELSEVIER LTD, JAI-ELSEVIER SCI BV, JAI-ELSEVIER SCIENCE INC, MOSBY- ELSEVIER, HANLEY &amp; BELFUS-ELSEVIER INC, NORTH HOLLAND, ELSEVIER SCIENCE PUBL BV, PERGAMON-ELSEVIER SCIENCE LTD, W B SAUNDERS CO-ELSEVIER INC, EXCERPTA MEDICA INC- ELSEVIER SCIENCE INC, GAUTHIER-VILLARS/EDITIONS ELSEVIER, EDITIONS SCIENTIFIQUES ET MEDICALES ELSEVIER, HANLEY &amp; BELFUS INC MED PUBLISHERS, JAI PRESS INC, MASSON EDITEUR, MASSON INT NURSING PUBLICATIONS, MASSON PUBL USA INC, MORGAN KAUFMANN PUB INC, MOSBY, INC, PERGAMON PRESS, PERGAMON PRESS CANADA, PERGAMON PRESS LTD, REED BUSINESS INFORMATION, REED BUSINESS INFORMATION LTD, REED BUSINESS INFORMATION US, REED HEALTHCARE COMMUNICATIONS, W B SAUNDERS CO LTD, URBAN &amp; FISCHER VERLAG</p>

TAYLOR & FRANCIS	TAYLOR & FRANCIS AS, TAYLOR & FRANCIS AUSTRALASIA, TAYLOR & FRANCIS INC, TAYLOR & FRANCIS LTD, CRC PRESS-TAYLOR & FRANCIS GROUP, ERLBAUM (UK) TAYLOR & FRANCIS PUBLISHERS, A A BALKEMA - TAYLOR & FRANCIS THE NETHERLANDS, GARLAND SCIENCE, TAYLOR & FRANCIS, CARFAX PUBLISHING-TAYLOR & FRANCIS GROUP, ROUTLEDGE JOURNALS, TAYLOR & FRANCIS LTD, AUERBACH PUBLICATIONS, TAYLOR & FRANCIS GROUP, HARWOOD ACAD PUBL GMBH, TAYLOR & FRANCIS GROUP, GORDON BREACH PUBLISHING, TAYLOR & FRANCIS GROUP, LAWRENCE ERLBAUM ASSOC INC-TAYLOR & FRANCIS, ROUTLEDGE, MANEY PUBLISHING, HAWORTH PRESS INC, HAWTHORN PRESS, MARCEL DEKKER, MARCEL DEKKER INC, LAWRENCE ERLBAUM ASSOC LTD, LAWRENCE ERLBAUM ASSOC LTD PUBL, LAWRENCE ERLBAUM ASSOC PUBL, FRANK CASS AND CO LTD, FRANK CASS CO LTD, LANDES BIOSCIENCE, HELDREF PUBLICATIONS, M E SHARPE INC, INFORMA HEALTHCARE, GORDON AND BREACH SCIENCE PUBL, CHAPMAN & HALL, CHAPMAN & HALL INC, CHAPMAN & HALL/CRC PRESS, CHAPMAN HALL LTD, VILNIUS GEDIMINAS TECH UNIV, VILNIUS GEDIMINAS TECHNICAL UNIV PRESS, TECHNIKA, HAWORTH HOSPITALITY PRESS, HAWORTH MEDICAL PRESS, CRC PRESS LLC
WILEY	WILEY, WILEY CHANCERY, WILEY EASTERN LTD, WILEY PERIODICALS, WILEY PERIODICALS, INC, WILEY-BLACKWELL, WILEY-LISS, WILEY-LISS, INC, WILEY-V C H VERLAG GMBH, WILEY-VCH, INC, JOHN WILEY & SONS, JOHN WILEY & SONS INC, JOHN WILEY & SONS LTD, SCRIPTA TECHNICA-JOHN WILEY & SONS, JOSSEY-BASS INC PUBL-JOHN WILEY & SONS, AMER GEOPHYSICAL UNION, MUNKSGAARD, BLACKWELL MUNKSGAARD, BLACKWELL PUBL, BLACKWELL PUBL LTD, BLACKWELL PUBLISHERS, BLACKWELL PUBLISHING ASIA, BLACKWELL PUBLISHING INC, BLACKWELL SCIENCE INC, BLACKWELL SCIENCE PUBL, BLACKWELL VERLAG GMBH, BLACKWELL WISSENSCHAFTS-VERLAG GMBH, ARNETTE BLACKWELL S A
SAGE	SAGE PUBLICATIONS INC, SAGE PUBLICATIONS INDIA PVT LTD, SAGE PUBLICATIONS INDIA PVT LTD, SAGE PUBLICATIONS LTD
OXFORD UNIVERSITY PRESS	OXFORD UNIV PRESS, OXFORD UNIV PRESS INC, OXFORD UNIV PRESS CAPE TOWN, OXFORD UNIV PRESS DELHI
CAMBRIDGE UNIVERSITY PRESS	CAMBRIDGE UNIV PRESS, CAMBRIDGE INTERNATIONAL SCIENCE PUBLISHING
IEEE	INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS INC.,

	IEEE COMPUTER SOCIETY, IEEE ADVANCING TECHNOLOGY FOR HUMANITY, IEEE SYSTEMS, MAN, AND CYBERNETICS SOCIETY, IEEE EDUCATION SOCIETY, INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS CANADA, INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, IEEE TECHNICAL COMMITTEE ON LEARNING TECHNOLOGY, IEEE SOLID-STATE CIRCUITS SOCIETY, IEEE POWER ELECTRONICS SOCIETY, IEEE GEOSCIENCE AND REMOTE SENSING SOCIETY, IEEE ELECTRON DEVICES SOCIETY, IEEE ELECTROMAGNETIC COMPATIBILITY SOCIETY, IEEE CONTROL SYSTEMS SOCIETY, IEEE COMPUTATIONAL INTELLIGENCE SOCIETY, IEEE COMMUNICATIONS SOCIETY, IEEE CIRCUITS AND SYSTEMS SOCIETY, ALASKA NURSES ASSOCIATION
THIEME	ONLY 5 TITLES ARE CURRENTLY SUBSCRIBED WITHIN “MINISTRY PROJECT”: PHARMACOPSYCHIATRY, PLANTA MEDICA, SYNFACTS, SYNLETT, AND SYNTHESIS
OPTICAL SOCIETY OF AMERICA	OPTICAL SOCIETY OF AMERICA
ROYAL SOCIETY OF CHEMISTRY	ROYAL SOCIETY OF CHEMISTRY
AMERICAN CHEMICAL SOCIETY	AMERICAN CHEMICAL SOCIETY
AMERICAN INSTITUTE OF PHYSICS	AIP PUBLISHING LLC, AMERICAN INSTITUTE OF PHYSICS, AMERICAN INSTITUTE OF PHYSICS INC., AMERICAN INSTITUTE OF PHYSICS PUBLISHING LLC
AMERICAN PHYSICAL SOCIETY	AMERICAN PHYSICAL SOCIETY
SPIE	SPIE-INT SOC OPTICAL ENGINEERING, SPIE-SOC PHOTO-OPTICAL INSTRUMENTATION ENGINEERS, IS&T & SPIE

As to our knowledge, this is the first time when analytical possibilities of InCites has been used for collection development and quantitative and qualitative evaluation of the level of information support of scholarly research.

Operators of RFBR project provided the data on the Elsevier and Springer-Nature usage statistics (full-text downloads in 2016). The usage data of MES project is available on the

webpage of Russian National Public Library for Science and Technology<sup>2</sup>. The following resources are considered as MES or “ministry subscription”:

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<sup>2</sup> URL: <http://konkurs.vlibrary.ru/?id=KonkursStaticStat>

- AAAS
- ACS
- AIP
- APS
- CUP
- IEEE
- IOP
- NPG
- OSA
- OUP
- RSC
- SAGE
- SPIE
- T&F
- Thieme
- Wiley

“RFBR subscription” includes Springer - Nature journal package and Freedom Collection of Elsevier.

## 4. Results

### 4.1. Analysis of publication output in Russia in comparison with world output by ESI classificatory

The publication distribution of Russian universities and research organizations in WoS CC over ESI research areas differs essentially from that of the world total (Fig.1).

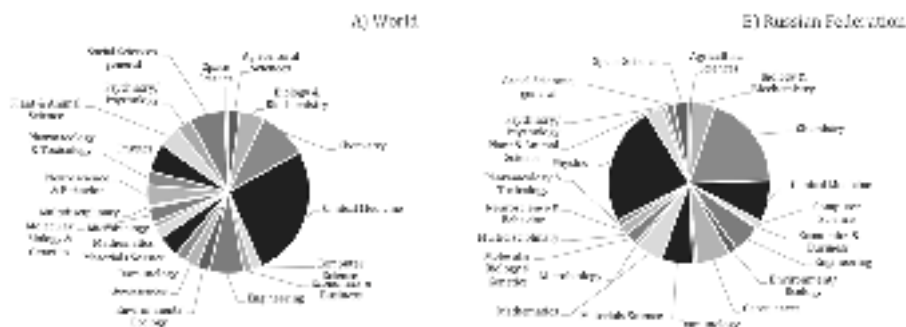


Fig.1. World (A) and Russian Federation (B) output in Web of Science Core Collection (2012-2016) by ESI research areas

A quarter of world publications are in Clinical medicine, while in Russia a half of publications are in Physics and Chemistry, Clinical medicine being only in the third place by number of publications. Such areas as Economics & Business, Immunology, Psychiatry/Psychology, Social Sciences are presented in Russian publications in WoS CC less than in world average, while Space Sciences, Geosciences and Materials Sciences occupy the larger share in total publication output than in world average.

Only leading multidisciplinary universities such as Moscow State University or Saint Petersburg State University (SPbSU) demonstrate almost the same distribution of publications as Russian average, other universities and research organizations have different distribution of research interests with prevalence of one or several research areas (Table 2).

Table 2. Research diversity in some Russian Universities as to compare with whole Russian Federation output and World output (WoS CC, 2012-2016)

	World	Russia	Moscow State University	St. Petersburg State University	Novosibirsk State University	Moscow Engineering Physical Institute	St. Petersburg Polytechnical University	Higher School of Economics
Physics	5.7%	23.6%	27.6%	21.5%	34.0%	67.1%	52.7%	14.6%
Chemistry	9.6%	19.1%	18.4%	24.6%	27.5%	8.8%	10.6%	2.0%
Clinical Medicine	26.2%	8.3%	2.8%	2.2%	1.7%	0.6%	1.1%	1.4%
Geosciences	2.5%	6.7%	5.1%	7.8%	8.5%	0.7%	0.8%	1.2%
Materials Science	4.3%	6.3%	3.8%	4.9%	3.3%	4.4%	9.9%	0.7%
Engineering	6.9%	5.6%	2.9%	4.0%	4.8%	9.2%	9.2%	6.7%
Mathematics	2.2%	5.2%	8.6%	7.4%	7.7%	3.2%	1.1%	25.5%
Biology & Biochemistry	4.9%	4.5%	8.3%	4.3%	3.3%	0.4%	4.5%	1.0%
Plant & Animal Science	4.3%	3.3%	4.0%	4.1%	0.8%	0.0%	0.2%	0.2%
Space Science	0.8%	3.0%	5.6%	5.4%	0.4%	2.9%	3.4%	1.3%
Molecular Biology & Genetics	3.0%	2.3%	3.1%	3.4%	3.5%	0.1%	1.7%	0.5%
Neuroscience & Behavior	4.0%	2.0%	1.1%	1.4%	0.7%	0.1%	0.7%	4.2%
Environment/Ecology	2.6%	1.7%	1.4%	1.2%	0.2%	0.1%	0.2%	0.3%
Social Sciences, general	7.0%	1.6%	0.7%	1.5%	0.3%	0.2%	0.2%	20.0%
Computer Science	2.0%	1.3%	0.9%	0.8%	0.9%	0.6%	1.1%	4.2%
Pharmacology & Toxicology	2.8%	1.2%	0.7%	0.6%	0.5%	0.1%	0.4%	0.5%
Psychiatry/Psychology	3.0%	0.9%	1.1%	1.5%	0.2%	0.3%	0.3%	5.5%
Microbiology	1.1%	0.9%	1.1%	1.2%	0.6%	0.0%	0.5%	0.0%
Immunology	2.1%	0.8%	0.2%	0.3%	0.3%	0.0%	0.2%	0.1%
Agricultural Sciences	2.3%	0.6%	1.7%	0.4%	0.1%	0.0%	0.0%	0.0%
Economics & Business	1.6%	0.3%	0.1%	0.6%	0.1%	0.0%	0.1%	8.9%
Multidisciplinary	0.4%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.2%

That is the reason of different approaches in formation of subscriptions to electronic resources on the level of separate organization or national level. The subscription in such universities as SPbSU can serve as model one for national subscription. On the other hand, we

must take into account that lack of publications in several research areas may be the consequence of insufficient access to information resources.

#### **4.2. Coverage of ESI research areas by national subscription in number of publications, citations, and proportion of highly cited papers**

One of the main criteria for subscription is the completeness of publication presentation. We evaluated this criterion by number of publications in Web of Science Core Collection through ESI research areas. The information on the absolute number of publications in journals of subscribed publishers is given in Table 3.

Table 3. Absolute number of articles, published in journals in subscribed resources (WoS CC, 2012-2016)

	Web of Science Documents	RFBR subscription		Ministry of Education and Science subscription															Other publishers
		Elsevier	Springer-Nature	Wiley	T&F	SAGE	OUP	CUP	IEEE	Thieme	AAAS	ACS	AIP	APS	IOP	OSA	RSC	SPIE	
Agricultural Sciences	221367	62782	22727	21941	11171	1346	388	5138			7	7024					1566		87277
Biology & Biochemistry	480522	124700	60644	60812	17132	596	12965	66			2133	11285			1272	1715	8542		178660
Chemistry	940410	212989	88813	107067	24496	3105	1524			4973	563	211472	20381		3426		122797		138804
Clinical Medicine	2561321	551194	402351	379118	52530	55869	114276	3611			279				727			2517	998849
Computer Science	198106	59016	36598	5835	3399	3447	5358	676	12093		15					722			70947
Economics & Business	152536	39333	21069	25217	16206	7249	5162	4035			101								34164
Engineering	670640	224473	77113	23397	40077	17786	321	5478	2661		31	4580	1585		5429	735		4922	262052
Environment/ Ecology	253782	56451	55551	39596	13665	781	585	1880			524	9047			1718		1652		72332
Geosciences	243617	64965	39111	14447	8028	1015	3002	1986			597				453			1034	108979
Immunology	209768	56822	29205	29397	7207	1719	8198				241								76979
Materials Science	421949	151794	58108	30406	15692	6219	5	4162			72	17758	7386		10588	1437	27481		90841
Mathematics	216083	48652	46687	8072	12819	512	3307	5561			8				792				89673
Microbiology	111994	18387	24807	6577	280		2790	926			185								58042
Molecular Biology & Genetics	295316	52995	65373	33888	10195		7649	1015			2212				2778		1436		117775
Multidisciplinary	39585	10445	10161	127	146		81				6670								11955
Neuroscience & Behavior	394612	111046	72900	60889	6500	17548	17709	3413			293	478	845		706			131	102154
Pharmacology & Toxicology	274875	74326	33008	38294	26886	5732	4590			5406	26	5321					1977		79309
Physics	552952	91142	77593	8324	8053		803	1056			713	6479	56644	94171	62650	35770	8950	670	99934
Plant & Animal Science	417843	62144	58204	57200	16652	2544	27420	4832			303								188544
Psychiatry/ Psychology	297138	56989	65398	40424	38998	27747	7378	6406			108								53690
Social Sciences, general	680643	95684	135233	78465	98498	76376	40858	34583	583		186						332		119845
Space Science	74541	6631	7372	766	162		16209	475			306				24329				18291



One can see that the world largest multidisciplinary publishers, such as Elsevier, Springer-Nature, Wiley, Taylor & Francis, et all provide access in all ESI research areas to more than a half of documents indexed in WoS CC.

However, resources of world leading learning societies are also of a great importance. ACS with its 48 titles provides 22.5% of WoS CC output in Chemistry being the world's second after Elsevier with 22.6%. That is why, the list of subscribed resources contains not only multidisciplinary but also specialized packages that add in Russian national subscription lots of high-quality articles. Along with 22.5% of ACS, RSC provides 13% of world flow in Chemistry. In Physics APS provides 17.0% of world output, AIP – 10.2%, IoP – 13.3%, OSA – 6.5%. The sum over those four learning societies gives 47% of WoS output in Physics – more than 33.5% provided by Elsevier, Springer-Nature, Wiley, and T&F. Besides IoP provides 32.6% of world output in Space Science, RSC – 6% in Material Sciences, and IEEE – 6% of Computer Science. These numbers indicate to a very important role of learning society publishers in information support that cannot be neglected. The analysis of all resources shows that in average the MES and RFBR subscriptions provide the access to about 70% of WoS CC content. The detailed information by ESI research areas is presented in Fig. 2.

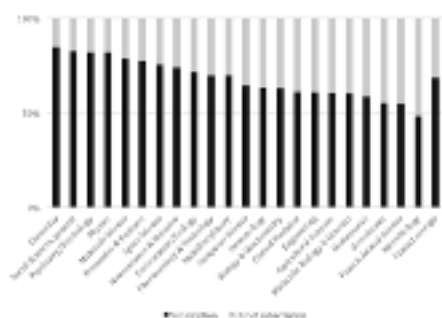


Fig.2. The proportion of articles in subscribed resources to world research output

The diagram in Fig. 2 shows that the best situation is with access to publications in Chemistry (about 90%) and the worst – in Microbiology (less that 50%). The input of RFBR and

MES subscriptions is almost equal (Table 3), though RFBR provides access only to Springer-Nature and Elsevier.

The quality of subscribed resources can be to some extent characterized by number of received citations (Fig.3).

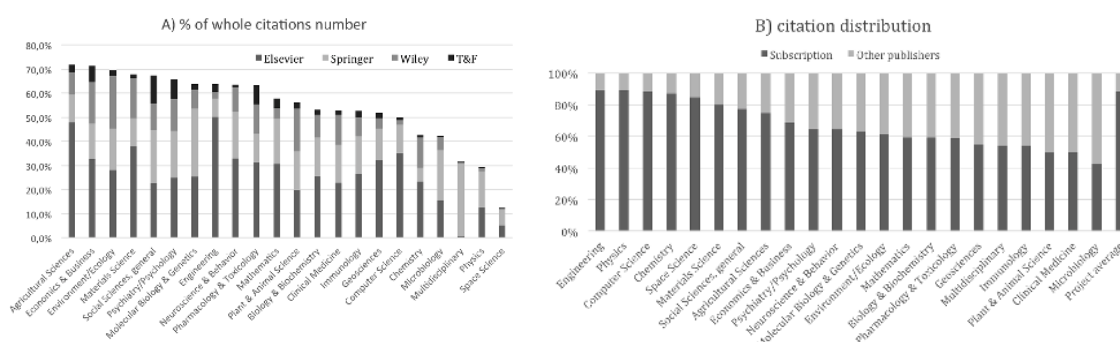


Fig. 3. The quality of subscribed resources by proportion of received citations (A – largest multidisciplinary publishers, B – Subscribed resources versus other publishers)

Fig. 3A shows that even multidisciplinary resources provide up to 70% of total citations in ESI research areas however, in Physics or Chemistry the learning society publishers such as APS or RSC play the most important role (compare Fig. 3A and Fig. 3B).

Even taking into account the strict rules for content selection in Web of Science Core Collection itself, one can see that subscribed resources present the highest-level journals. For example, more than 70% of journals in Elsevier Freedom collection (RFBR subscription) are in Q1 and Q2 by their impact-factor and only 11% are in Q4. For certain research areas the situation may differ but in the whole the number of Q1 and Q2 journals in subscribed resources is higher than Q3 and Q4.

The number of citations by publishers (in percent of total citations) depends mainly on total number of publications, so more adequate indicator of quality is average citation per publication or such indicator as Category Normalized Citation Impact (CNCI). CNCI shows the relation of

average citation in selected papers to world average in the same subject category taking into account the date of publication and its type (article, review, et al.). In Physics, for example, the total citation number is counted for APS journals, while the highest CNCI value is demonstrated by physical publications in AAAS and journals of ACS and RSC.

### 4.3. Open access journals in subscribed resources

The common trend of research organization now is open access to research information, including publications in scholarly journals. The number of OA journals is growing, many journals with traditional subscription models use the hybrid approach and publish some articles in open access for additional charges (Article Processing Charge, APC). The proportion of OA articles in WoS CC (only full OA journals) grew from 6.8% in 2012 up to 10.6% in 2016, increasing the availability of full-texts to researchers. The proportion of OA journals in subscribed resources under consideration is much lower than for other publishers (Table 4) and differs greatly for certain ESI research areas. This data coincides with the data on different types of OA across publishers and disciplines in [35].

Table 4. The proportion of publications in open access journals in WoS CC

	%OA in Wos CC	%OA in subscribed publishers	%OA in other publishers
Microbiology	29.3%	7.8%	21.5%
Multidisciplinary	24.7%	0.1%	24.5%
Molecular Biology & Genetics	20.7%	7.7%	13.0%
Immunology	18.2%	4.4%	13.9%
Biology & Biochemistry	14.4%	4.0%	10.4%
Environment/Ecology	13.0%	2.8%	10.2%
Plant & Animal Science	12.6%	2.3%	10.4%
Agricultural Sciences	12.3%	1.4%	10.9%
Geosciences	12.0%	0.9%	11.2%
Neuroscience & Behavior	11.7%	2.2%	9.5%
Mathematics	9.3%	2.8%	6.5%
Clinical Medicine	8.7%	2.5%	6.2%
Physics	8.5%	4.9%	3.5%
Psychiatry/Psychology	7.9%	2.0%	5.9%

Social Sciences, general	6.8%	2.8%	4.0%
Computer Science	6.2%	3.9%	2.3%
Materials Science	6.2%	1.4%	4.8%
Pharmacology & Toxicology	5.9%	0.7%	5.1%
Engineering	5.6%	1.1%	4.5%
Chemistry	4.9%	0.3%	4.6%
Economics & Business	2.4%	0.2%	2.3%
Space Science	1.3%	0.0%	1.3%

The proportion of OA journals for different research areas is to be taken into account while selecting the resources for subscription. For example, the highest level of OA for Microbiology compensates the low availability of journals on microbiology in subscribed resources. The negative correlation of OA (percent of total publications in ESI subject area) and availability of subscribed journals is demonstrated in Fig. 4.

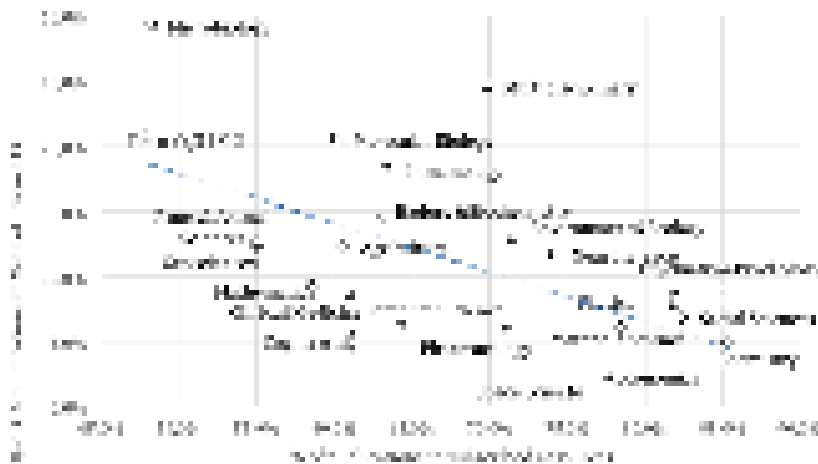


Fig.4. Proportion of OA publications and share of research output provided by subscribed journals

We obtained the availability of full-texts with taking into account the OA journals (Fig. 5).

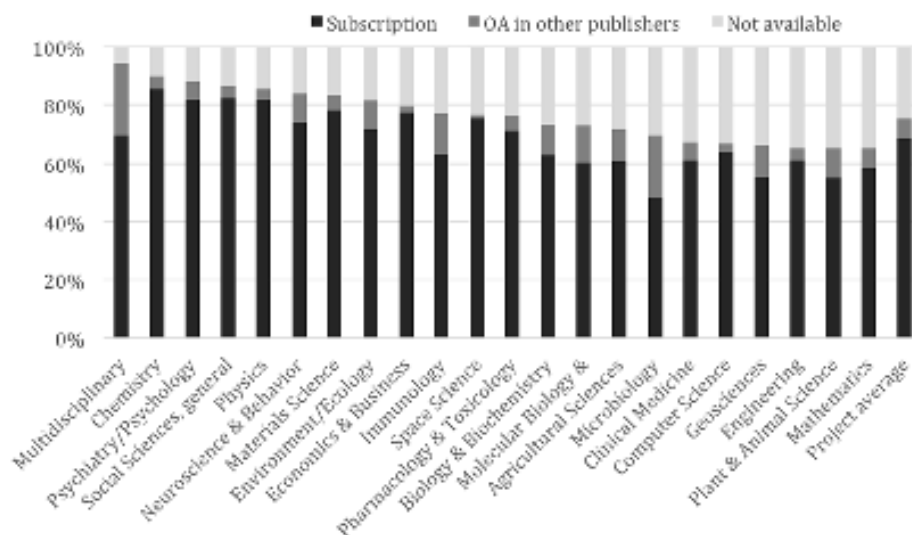


Fig.5. Availability of publications in WoS CC by ESI research areas (per cents of total number in category)

One can see that real proportion increases from 68% average for subscribed resources (Fig. 2) to 75%. The low level of availability in Microbiology, Plant & Animal Science and Geosciences (about or less than 50%) is compensated with relatively high proportion of OA journals.

#### 4.4. Russian publications in subscribed journals

One of the principles for resource selection for subscription is their usability not only as sources of information but also as channels of scientific communication, namely, publication of research results. We analyzed distribution of Russian publications in journals of different publishers and discovered that more than a half are published in the journals presented in Springer-Nature and Freedom Collection of Elsevier, i.e. subscribed by RFBR.

About 82% of Russian publications are in journals subscribed in the frame of MES and RFBR subscription. Almost all Russian publications in chemistry, physics and other natural sciences are in subscribed journals (Table 5).

Table 5. Total distribution of Russian publications by journals availability

	Total number			% of total	
	Web of Science Documents	Subscribed publishers	Other Publishers	Subscription	Other publishers
Chemistry	33530	31617	1913	94.3%	5.7%
Agricultural Sciences	1128	1033	95	91.6%	8.4%
Engineering	9883	8870	1013	89.8%	10.2%
Physics	41534	36809	4725	88.6%	11.4%
Computer Science	2261	1995	266	88.2%	11.8%
Environment/Ecology	2959	2577	382	87.1%	12.9%
Materials Science	11143	9569	1574	85.9%	14.1%
Biology & Biochemistry	7929	6710	1219	84.6%	15.4%
Geosciences	11743	9638	2105	82.1%	17.9%
Economics & Business	522	418	104	80.1%	19.9%
Space Science	5266	4160	1106	79.0%	21.0%
Pharmacology & Toxicology	2063	1627	436	78.9%	21.1%
Immunology	1349	1045	304	77.5%	22.5%
Mathematics	9060	6739	2321	74.4%	25.6%
Psychiatry/Psychology	1653	1189	464	71.9%	28.1%
Molecular Biology & Genetics	4109	2825	1284	68.8%	31.2%
Clinical Medicine	14592	9275	5317	63.6%	36.4%
Microbiology	1612	1010	602	62.7%	37.3%
Neuroscience & Behavior	3473	2129	1344	61.3%	38.7%
Social Sciences, general	2781	1609	1172	57.9%	42.1%
Multidisciplinary	102	56	46	54.9%	45.1%
Plant & Animal Science	5733	2523	3210	44.0%	56.0%
Project average	174425	143423	31002	82.2%	17.8%

The total number of publications in journals of subscribed publishers increases faster than in other journals. The share of Russian publications in journals of unsubscribed publishers decreased from 18.7% in 2012 to 17.2% in 2016. The total number of publications in subscribed journals increased from 2012 to 2016 by 29%, while in journals of other publishers by 16%. The distribution by ESI categories remains stable in analyzed period.

It should be considered that ESI categories do not include Arts & Humanities, while the total number of Russian publication in AHCI increased twice from 2012 to 2016 (0.4% of world output in 2012 and 0.9% in 2016), half of them annually published in subscribed journals (0.3% of world output in journals of subscribed publishers in 2012 and 0.6% in 2016).

The number of published articles correlates strongly with the number of downloaded articles, at least for publishers under consideration (Fig.6).

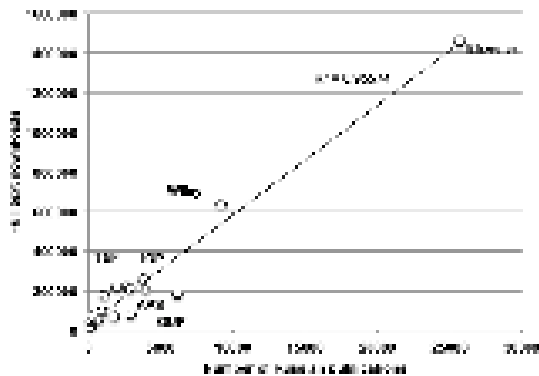


Fig. 6. Dependence of number of published papers (Russian Federation, 2012-2015, WoS CC) on number of downloaded articles. Correlation  $r=0.98$  (Pearson)

This coincides with the published data about dependence of research output on readership. However, it should be emphasized that all previous data has been reported either on a country, institutional or research area levels [9,11,12]. Here, for the first time, we report correlation between research output and readership for a set of separate packages of resources.

Dependence of publication output on total readership on an institutional level for the case of SPbSU is shown in Fig. 7.

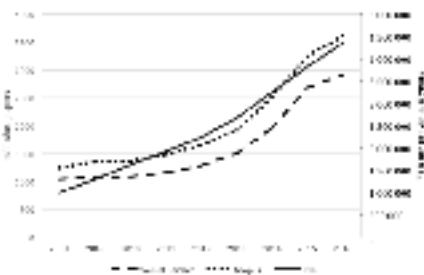


Fig. 7. Correlation of full-text downloads and published papers in Saint-Petersburg State University

SPbSU is having one of the best repertoires of subscribed resources in Russia, both thanks to state project and own university subscription. The list of subscribed resources increased from

2008 to 2016 almost three times, including permanent access to purchased Elsevier backfiles. The number of full-text downloads increased during this period more than 4 times and correspondingly the publication output grew about three times both in WoS CC and Scopus. The increase in the number of downloads is determined not only by the more active use of resources but also by the growth in the number of users, and as a consequence, by an increase in the number of authors of scientific publications. According to SciVal data, the number of authors affiliated with SPbSU increased from 1669 in 2012 to 3704 in 2016 (the growth is more than 120%). The analysis of SPbSU publication activity by Russian Index of Science Citation also demonstrates both growth of publications and number of authors together with the increasing of full-text downloads from RISC.

In our study we have experimentally obtained that the number of downloads in Russia depend directly on the number of articles available in the subscribed resources (Fig. 8).

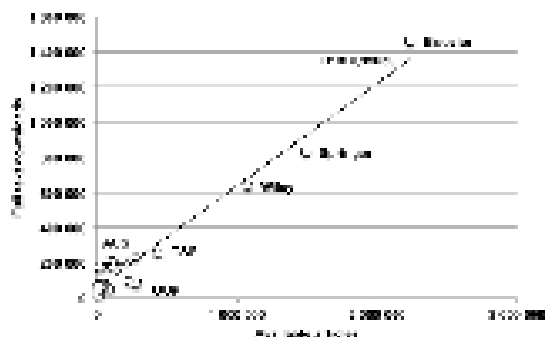


Fig.8. Dependence of full-text downloads on the number of available articles in resources under subscription. Correlation  $r=0.98$  (Pearson)

However, the reason of it is somewhat unclear. This fact could indicate that informetric laws (Pareto principle and Leimkuler curve) are not valid in this particular case when both packages of articles and ensemble of users were specially prepared. Noteworthy is that in our attempts to check the Lotka's law with usage statistics data obtained for the same packages, we also have found that the Lotka's law does not work in our case. Another explanation is that usage



of electronic resources in Russian educational and research organizations is still far from saturation. For example, in Saint-Petersburg State University – the heaviest user in Russia, the number of full-text downloads per user amounted to about 100 articles in 2016, while in Great Britain such activity of users was characteristic for Consortium of University Research Libraries in 2010-2011 [36]. Thus, we are going to further investigate this in more detail.

To conclude, for the studied set of thoroughly selected resources and optimized numbers and particular lists of subscribers we can note a strong correlation ( $r=0.98$ , Pearson) between Russian research output and the number of articles available through the studied set resources subscribed within the Russian System of Information Support.

## **5. Discussion**

Russian science reveals its specifics and differs essentially from that of the world total in terms of distribution of research output over research areas. More than a half of Russian publications in 2012-2016 are concentrated in two ESI research areas: Chemistry and Physics. This results from the specially organized R&D funding in Russia that covers five priority areas of Russian Science and Technology: Life Sciences; Industry of Nanosystems; ITC Systems; Environmental Management; Energy Efficiency, Energy Saving and Nuclear Energy and to a certain extent confirms the well-known fact that research output strongly correlates with funding. Since 2006 the state-funded subscription in Russia has been also focused at the five priority areas, so that the parameter of information support in those areas is high. In this study we have extended the field of our analysis to 22 ESI research areas. Results show that 16 full-text resources of current Russian national subscription, which were previously selected to fit five priority areas of Russian Science and Technology, reveal very high values of parameters of information support in all research areas of the ESI classificatory. If we take into account only

journal packages of first seven world top multidisciplinary publishers: Elsevier, Springer-Nature, Wiley, T&F, Sage, OUP and CUP we find that they cover more than 50% of world coverage in number of publications and citations. However, these high numbers are not sufficient to provide information in top research areas for Russian science, namely, Chemistry, Physics, Geoscience, Space Science and Computer Science. The lack of information in those areas is compensated due to resources published by world leading learning societies: ACS, RSC, APS, AIP, IoP, OSA, and IEEE. Those societies provide also the highest percentage of citations in key areas of Russian research: Physics and Chemistry. Therefore, one can conclude that despite a relatively low number of titles published by learning societies as compared to top multidisciplinary publishers, they are of key importance for the Russian and world research in Chemistry, Physics, Engineering and Computer Science. The numbers for 16 resources are as follows:

1. Coverage by the number of world publications varies over research areas from 85% in Chemistry to 48% in Microbiology and exceeds 55% for all ESI areas except Microbiology.
2. Coverage by the number of Russian publications - from 94% in Chemistry to 43% in Plant & Animal Science and exceeds 60% for all ESI research areas except Social Science, general and Plant & Animal Science.
3. Coverage by the number of world citations – from nearly 90% to 42%.
4. Coverage by the number of citations in Physics: 30% are provided by APS articles and only 13% and 12%, respectively, by Springer-Nature and Elsevier.
5. Open Access journals available via resources not included in national subscription compensate lack of information in such research areas as Microbiology and Plant & Animal Science and make parameter of information support to exceed 65% for all ESI subject areas.

For Russia, we report experimental data on strong correlation and linear dependence between research output and a number of full-text downloads from resources included in state-funded subscription. The linear dependence is confirmed both on national level and an example of a particular organization, namely, SPbSU – the second most productive university in Russia,

This fact is also supported by experimental temporal dependence of continues concentration of Russian articles in journals included in national subscription.

We also experimentally obtained linear dependence and strong Pearson correlation between the number of full-text downloads and the number of available articles in resources under subscription. This fact has not been reported in the literature yet and therefore needs further investigation.

Thus the existing state-funded subscription meets and satisfies the basic information needs of Russian science. The journals in the subscribed packages of world leading publishers investigated in this study are the main channels for publication of research results in Russia. Strong correlation of full-text downloads with research output in Russia demonstrates the necessity of further improvement of information support in all research areas, especially those which are insufficiently presented in the world information space (social sciences and humanities). Results obtained demonstrate applicability of InCites instruments for collection development and evaluation. The study was performed in Russian research and information surroundings, however, results and methods could be easily adjusted to any set of resources presented in WoS CC.

## **6. Acknowledgements**

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