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SCIENTIFIC COOPERATION OF RUSSIA (1990—2024): A COMPARATIVE STUDY OF THE BALTIC AND INDIAN REGIONS

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The article explores the reorientation and transformation of Russia's international scientific cooperation across its eastern and western strategic axes. This study is relevant due to the practical emphasis on international scientific cooperation as a necessary condition for the advancement of modern science. The objective of the research is to evaluate the restructuring of Russia's international scientific ties over the past 30 years at the macroregional level. The methodology employed is based on spatial scientometrics, which enables the geographical analysis of science using extensive bibliometric data. The study focuses on the Baltic and Indian regions and covers the period from 1990 to 2024. The data source is Scopus international database. The results obtained allow for conclusions regarding the position of the macroregions globally, in terms of the growth of scientific knowledge, the contribution of individual countries to the macroregional dynamics of publication activity, and the degree of Russia's integration into the scientific spaces of the Baltic and Indian regions. It is demonstrated that the Baltic region holds a stable global position in terms of the number of academic publications, exhibiting a slight but steady annual increase alongside high scientific productivity. Conversely, the Indian region is more dynamic scientifically but shows a greater centralisation of scientific activity and comparatively lower productivity. Russia participates in scientific collaboration with both macroregions. Collaboration with Baltic region countries has experienced stagnation, which has intensified since 2022. In contrast, joint publication activity with coun-

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tries in the Indian region has shown notable growth. This underscores the need for further qualitative research to achieve a more comprehensive understanding of the evolving global geography of science and Russia's role within it.

Keywords:
geography of science, spatial scientometrics, scientific publications, scientometric analysis, publication activity, Baltic region, Indian region, Russian-Indian cooperation, turn to the East

Introduction and problem setting

Russia's pivot to the East, accompanied by a marked shift towards broader engagement with developing nations, has sparked debate about its causes and implications for the country [1; 2]. It has been argued that the reconfiguration of international ties in favour of the fast-growing countries of Asia, South America and Africa is a natural process reflecting a long-term trend towards the redistribution of global geopolitical, economic and technoscientific power [3]. It is suggested that Russia should not only take into account the de facto redistribution of power and the growing prominence of developing countries, but also strengthen its role in their research and technological agendas. An alternative perspective highlights the involuntary nature of this restructuring of ties [4; 5]. The central argument is that the opportunity to engage with China, India, Brazil, Iran and other countries of the Global South has always existed. Yet, Russia — like most countries of the Global North — continued to adhere to an established model of cooperation centred around traditional Western power hubs — the US, the United Kingdom, Germany and France.

The narrowing gap between the North and the South, the weakening of Anglo-Saxon global dominance, and the formation of a new world order with multiple growth poles indicate the peril of artificially preserving the current development path. Conversely, altering this trajectory proves highly challenging and acutely sensitive due to the ingrained resistance of a deeply entrenched system [6]. In this context, the concept of 'new development trajectories', once popular in the 1980s [7], has regained contemporary relevance in Russia and internationally. For most governments, the challenge in formulating a national development strategy lies not in returning to the pre-crisis state (i. e., achieving stability), but in adapting to present and emerging circumstances over the medium to long term, ensuring the effective transformation of the system within a new framework of connections (i. e. resilience).

This study aims to examine the ongoing transformations shaping Russia's scholarly connections. Particular attention is given to evaluating Russia's engagements with the Baltic and Indian macro-regions. The Baltic area has historically been a hub of collaboration for Russia and a focal point due to the presence of global leaders in research, technological and innovation rankings (e. g.,

the European Innovation Scoreboard).[1] The Indian macro-region is considered a promising avenue for cooperation, with India, Russia's strategic partner and the world's most populous nation, at its core. Despite the long-standing history of the Russian-Indian partnership, often described as stable ('this bond is so strong that it is difficult to break' [8, p. 70]), recent events have intensified the focus on the cooperative agenda between the two countries. During one year, from 2021 to 2022, Russia advanced from 25th to 7th place in trade volume with India, boosting its trade turnover to $18 billion [9]. Thus, it is reasonable to propose that the growth of bilateral economic relations is fostering potential for further areas of Russian-Indian cooperation, including in science.

The following section provides an overview of studies documenting the current changes in the global distribution of research contributions. The methodology section outlines the protocol of this study, using spatial scientometrics to analyse territorial patterns of international research collaboration. The study is based on data from two macro-regions — the Baltic and Indian. The results are organised into three subsections. The first discusses the position of the Baltic and Indian regions as major centres for research and their changing influence on the growth of knowledge. The second presents data on the contributions of individual countries to the macro-regional publication patterns. The third evaluates Russia's involvement in research cooperation with countries from the Baltic and Indian regions. The work concludes with key findings on the role of the West and East in shaping Russia's international academic connections and provides recommendations for potential avenues for future research.

Theoretical framework

The effective functioning of a country's national innovation system requires several essential conditions, which can be grouped into three categories:

— developed scientific, educational and industrial sectors (including high-tech and capital-intensive enterprises with high added value) and a system of dedicated state institutions;

— a supportive institutional environment that fosters multilateral connections between academic, corporate, governmental and non-profit structures;

— an extensive network of international cooperation, operating on mutually beneficial terms and facilitating the diffusion of knowledge and innovations.

This final point is of particular relevance to the present study. Recent findings confirm the thesis that research is becoming increasingly complex, as the resources of a single country are no longer sufficient for innovation [10; 11],

[1] European innovation scoreboard. Research and innovation, *European Commission,* URL: https://research-and-innovation.ec.europa.eu/statistics/performance-indicators/european-innovation-scoreboard_en (accessed 11.11.2024).

while the innovation process itself is characterised by nonlinearity and glocalisation [12]. The presence of connection points between domestic systems at various levels and international scientific, technological and innovation clusters (the so-called 'knowledge pipelines' [13]) plays a critical role in national innovation development.

Despite the apparent decline in the territorial determinism of knowledge, partly due to the emergence of digital access to research results, the competencies for its reproduction, expansion and application remain closely tied to specific research organisations and teams [14]. The US and Western European countries have the most established scientific and technological systems, which for a long time enabled them to dominate as global centres for the production of new knowledge [15; 16]. However, the global research landscape is evolving: the balance of power is slowly shifting, and research is increasingly centred in developing countries. Since the late 20th century, there has been mounting discussion of a pivot in global science towards the East [17], particularly evident in the fields of space exploration, aviation, telecommunications, nuclear energy and high-speed transport [18].

The race for new knowledge [19], fuelled by the growing number of countries adopting a knowledge-based economy [20], has highlighted the need for developing nations to bolster their research and technological capacity. The first shift was marked by Japan's rapid growth, followed by Taiwan, Hong Kong, Singapore and South Korea — the newly industrialised countries of East Asia and full participants in the global competition [21]. However, Singapore and Hong Kong have already begun to lose their competitive edge as international competition in research intensifies [15]. In 2012, China overtook South Korea and Taiwan in the volume of publications [21], and it now surpasses the US in overall research output.

Since 2015, the BRICS countries (Brazil, Russia, India, China and South Africa) have accounted for over a quarter of global research publications, emerging as alternative centres of 'new knowledge production, modern technology and innovation-driven development' [22, p. 1116], while the rise of East Asian innovation systems has diminished the global share of the US, the EU and Japan in generating research publications and patents [23]. The growing research activity in China, India and South Korea has significantly disrupted the global balance of publications [24, p. 121]. While in 2015 the eastern presence was still emerging and India had yet to awaken [24], the situation changed markedly a decade later.

Since the early 21st century, research has become less polarised, with a growing trend towards its redistribution as developing countries enhance their research and technological capacities [25].

Interest in the Global South as an academic partner has grown, both from within these countries and the West [26]. Yet, building such ties is complicated not only by the lack of geographic proximity between the Global North and South but also by their social and cognitive divergence [27]. For many years, Russia concentrated its efforts on integrating into the Western academic community, participating in major joint projects [28], securing broad representation in leading international citation databases and entering global university rankings (QS, THE, ARWU), among other initiatives. The current context of heightened geopolitical tensions has amplified the need to expand and restructure research collaboration to align with the new geography of knowledge production.

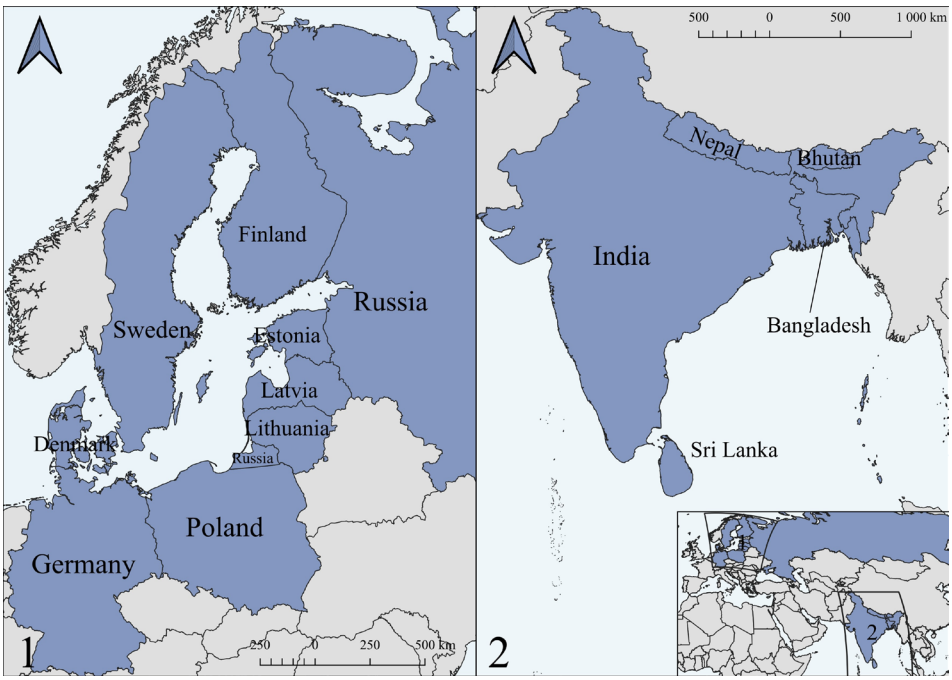
Data and methodology

Geographical scope

The spatial scientometric assessment of Russia's international scholarly collaboration in the West (Europe) and East (Asia) focuses on two macro-regions defined by cultural and historical commonalities — the Baltic and Indian regions (Fig. 1). The Baltic region includes Russia and eight other countries — Germany, Poland, Denmark, Sweden, Finland, Lithuania, Latvia and Estonia, while the Indian region comprises five countries: India, Sri Lanka, Bangladesh, Nepal and Bhutan.[1] According to the Worldometers statistical service, as of 2024, the countries of the Baltic region, excluding Russia, account for 20.3 % of the total population of Europe, and the countries of the Indian region account for 35 % of the total population of Asia, making these macro-regions significant areas for the accumulation of human and intellectual capital.

Germany, Sweden, Denmark and Finland — the most advanced countries of the Baltic region — not only rank among the world's top performers in research output but are also deeply integrated into international scientific and technological cooperation [30]. They are also among the countries recognised as global leaders in innovation [31], distinguished by substantial investment in research and development, both in absolute terms and relative to GDP, and by a high number of researchers measured in full-time equivalents [32]. The outflow of academic talent and highly skilled workers from the Baltic States has contributed to strengthening the region's northern and western countries, as around half of those who emigrated from Lithuania, Latvia and Estonia in the early 2000s remained within the macro-region, rapidly integrating into its research and innovation networks [33]. While the Baltic States possess more modest research and technological capacities than other countries in the region [31], they still surpass, for example, those of Central Asian countries [34].

[1] Gogolev, F. 2019, Sovremennye makroregiony: problemy klassifikatsii [Contemporary Macrorregions: Classification Issues]. June 4, 2019. *Russian International Affairs Council*, URL: https://russiancouncil.ru/blogs/svfu-experts/sovremennye-makroregiony-problemy-klassifikatsii (accessed 11.11.2024).



a *b*

Fig. 1. Geographical scope of the study: *a* — Baltic region; *b* — Indian region

The principal country within the Indian region is India. According to the World Bank,[1] the country ranks fifth globally in terms of GDP, behind only the US, China, Germany and Japan. In the Nature Index[2] of the top countries in research, India outperformed Australia, Italy and Switzerland, securing 9th place overall and 8th in the natural sciences. In the Global Innovation Index,[3] India is listed 39th among 133 countries and ranks first in Central and South Asia. As one of Asia's most influential states, India consistently extends its interests to neighbouring countries. As early as 1979, it articulated a policy of regional dominance in South Asia [35], which later evolved into the Look East foreign policy strategy with a broader geographical scope [36]. The institutional framework for cooperation in the macro-region was laid with the establishment of the South Asian Association for Regional Cooperation (SAARC) in 1985. Its principal aims included fostering the socio-economic development of the territories of historic

[1] *World Bank Data Catalogue, Gross domestic product ranking table*, 2023, URL: https://datacatalog.worldbank.org/search/dataset/0038130 (accessed 11.11.2024).

[2] *The Nature Index 2024 Research Leaders*, 2024, URL: https://www.nature.com/nature-index/research-leaders/2024/country/all/global (accessed 11.11.2024).

[3] *Global Innovation Index 2024*, 2024, URL: https://www.wipo.int/gii-ranking/en/india (accessed 11.11.2024).

India [36], establishing a free trade area [37] and advancing a unified educational space [38]. In the 1990s, cross-border cooperation within the macro-region gathered pace, driven chiefly by India, Bangladesh and Sri Lanka, and led to the formation of a zone of mutual gravitation [35]. In 2012, India's Ministry of External Affairs established a dedicated Development Partnership Administration, tasked with grant funding, investment and oversight of projects in neighbouring countries [35]. Thus, like the Baltic region, the Indian region is based not only on cultural and historical commonalities but also on institutional foundations shaped by current foreign policy agendas.

The Baltic and Indian macro-regions were selected as objects of this study for several reasons.

First, the countries in each grouping are geographical neighbours connected by cultural ties and shared historical experience — factors that support the development of a sustainable macro-regional research and innovation system involving these states. The social and cognitive affinity among researchers seems to be equally vital to knowledge exchange and the development of academic networks [27] as geographical and infrastructural proximity [39]. Until 2022, Russia was deeply integrated into the Baltic region, including through participation in initiatives addressing Baltic Sea-related issues. Although the Indian region does not include Russia, Soviet cultural codes, as Tatyana Erokhina notes [40], continue to forge a strong bond between Russia and India, helping to overcome geographic distance and ease interpersonal connections. In this context, it is both relevant and useful to compare these two macro-regions in terms of their evolving academic ties with Russia. In this context, a comparison of the two macro-regions with regard to their evolving academic relations with Russia appears both interesting and constructive.

Second, both macro-regions' research systems include major drivers — countries that are global leaders in science. Germany holds a dominant position in the Baltic region, ranking 5th in the world in 2023 by publication output, while India leads the Indian region, ranking 3rd globally in the same year. These macro-regions thus offer a valuable framework for analysing the West–East dichotomy in Russia's academic relations, particularly at the level of rapidly developing leading global research centres.

Third, the Baltic and Indian macro-regions represent the western and eastern vectors of cooperation. The Baltic region unites Russia's traditional European partners, who have increased sanctions pressure since 2014, viewing Russia as a key threat to national security. The Indian macro-region, in turn, comprises rapidly growing, densely populated countries where cooperation takes place on mutually beneficial and equal terms, guided by a long-term partnership strategy.

Data collection and analysis

This study of the research landscape and international research and technological cooperation is based on a spatial scientometric assessment of research output indicators. The analysis uses time series of geocoded data on the number of research publications, broken down by macro-regions and individual countries. The dataset covers the period from 1990 to November 2024.

This study relied on the international abstract database Scopus as its information source. This database was selected due to its multiple advantages for conducting international comparisons. First, it provides the necessary functionality to perform comprehensive search queries across various territorial levels. The availability of verified researcher and organisation profiles ensures high accuracy in matching affiliation data. Second, the database is accessible remotely through an application programming interface (API),[1] enabling integration with custom analytical tools to collect and export bibliometric data. A Python script was developed for API integration within the Visual Studio Code (VSCode) development environment. Third, this abstract database offers broad geographic coverage, including publications from developing countries in the Indian region. Fourth, the database is multidisciplinary, equally well indexing research outputs across all fields of knowledge. Fifth, unlike open databases, Scopus maintains a clear list of indexed publications, which are not only evaluated during selection but also subject to ongoing quality monitoring during indexing.

To ensure accurate data collection, a list of countries under study was compiled, with variations in their names matched against records in the Scopus database. Complex search queries were created for each macro-region to avoid duplication of publications when aggregating data by country. Collaborations were accounted for by considering both the share of a country's or macro-region's participation in Russia's total publications and Russia's share in the publications of the analysed country or macro-region.

The search query string used in the database to assess Russia's cooperation with the Baltic macro-region countries was as follows: *AFFILCOUNTRY ("Germany" OR "Denmark" OR "Latvia" OR "Lithuania" OR "Sweden" OR "Finland" OR "Estonia" OR "Poland") AND AFFILCOUNTRY (Russian Federation)*. The following string was used in the case of the countries of the Indian macro-region: *AFFILCOUNTRY("Bangladesh" OR "Bhutan" OR "India" OR "Nepal" OR "Sri Lanka") AND AFFILCOUNTRY(Russian Federation)*.

The search was not limited by document type, enabling the analysis of trends in diverse research outputs over an extended period. To assess spatial autocorrelation of research output within macro-regions, the spatial autocorrelation tool

[1] Elsevier Application programming interface, 2024, URL: https://dev.elsevier.com (accessed 11.11.2024).

(Moran's I) was used, calculated with GeoDa software. Due to the small number of objects, weights were assigned based on the distances between the centroids of countries. The weighted data were processed using the Univariate Moran's I algorithm. The index ranges from −1 to 1, where values close to zero indicate a random spatial distribution of the observed phenomena.

Results

The Baltic and Indian regions on the research map of the world

At the present stage, the Baltic and Indian regions — identified based on cultural and historical commonalities — are major centres for research, both on a global scale and within their respective geographic macro-regions: Europe and Asia. However, an analysis of publication data over more than thirty years reveals substantial interregional differences in the pace of quantitative knowledge growth. Figura 2, *d* illustrates changes in the contribution of these macro-regions to the global publication landscape. Whereas the Baltic region's average share of global research publications remained relatively stable between 1990 and 2023, at 11.9 %, fluctuating between 9.8 % and 13.4 %, the Indian region markedly enhanced its research visibility, increasing from 1.6 % in 1990 to 8.6 % in 2024 (as of November).

At the level of geographic macro-regions, the disparity in knowledge growth, as reflected in publication output, has persisted between the Baltic and Indian regions. The Baltic region's contribution to Europe's total publication volume remained relatively stable throughout the period under review, averaging 35.6 %. The Indian region's share in Asia's pool of research publications was more modest (13.2 % overall). Yet, after falling to 9.0 % in the early 2000s, it rose to 16.1 % of all Asian publications by 2024 (see Fig. 2, *c*).

Between 1990 and 2000, the Baltic and Indian regions exhibited a significant disparity in research publication output, with the latter lagging behind by a factor of six (see Fig. 2, *a*). In 1990, the Baltic region contributed 90,400 publications to the growth of knowledge, while the Indian region accounted for 15,200 publications. The largest gap, recorded in 1995 at 7.1 times, resulted from diverging trends: declining publication activity in the Indian region and growth in the Baltic region. Since the early 2000s, a trend toward convergence in annual publication volumes between the macro-regions has emerged, partly driven by increased publication activity in the Indian region (see Fig. 2, *b*). In 2023, the two macro-regions came closer in their annual contribution to the global publication volume: the Baltic region with 401,900 publications (365,700 excluding Russia) and the Indian region with 302,400 publications (see Fig. 2, *a*). Although data for 2024 are incomplete, it is evident that the Indian region continued to boost its publication performance, reducing the gap with the Baltic region to 1.3 times, or 1.09 times excluding Russia.

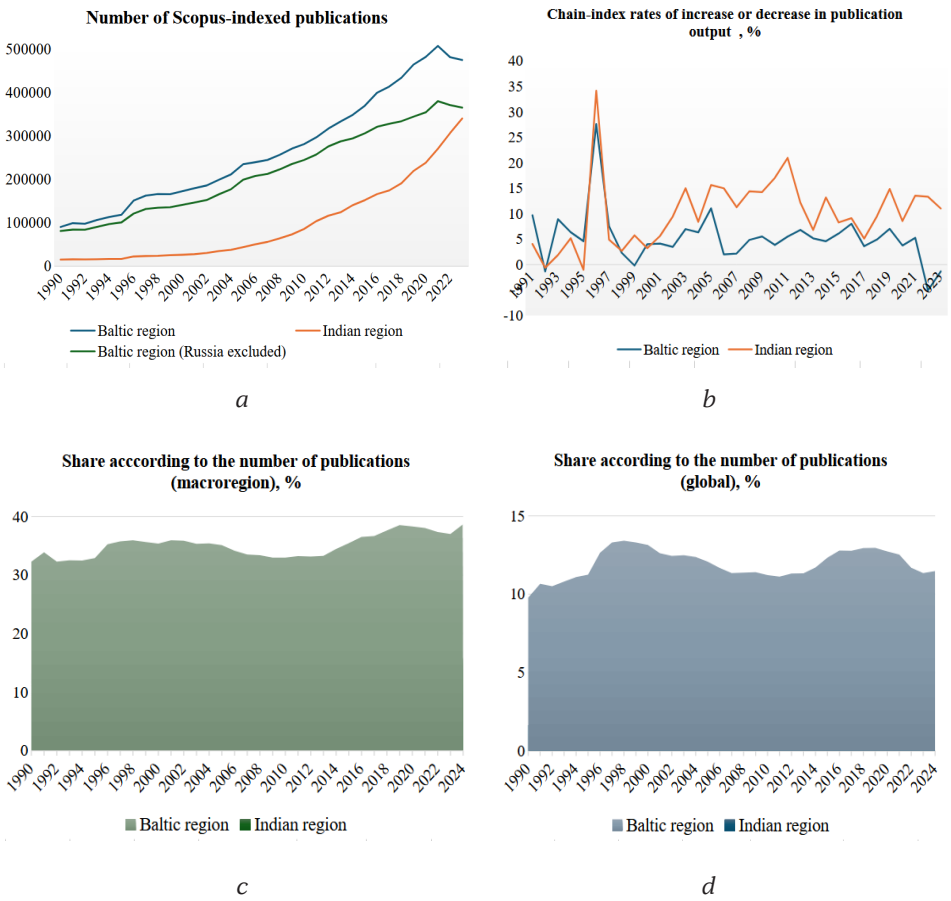


Fig. 2. Changes in the number of research publications in the Baltic and Indian regions, 1990 — November 2024

Comment: the indicators calculated for the Baltic region include data for Russia.

Prepared based on Scopus data.[1]

Thus, as a first approximation, assessing the West—East dichotomy in publication output growth across the examined macro-regions reveals a gradual restructuring of the territorial organisation of knowledge worldwide, with a tendency towards the East increasing its presence. In turn, this creates objective conditions for growing interest in expanding Russia's research cooperation with eastern countries as rapidly developing global research centres. Thirty years ago, the Asian avenue of international academic cooperation was less attractive to Russia due to the modest contribution of these countries (including those within the Indian macro-region) to the global quantitative growth of knowledge. Cur-

[1] Scopus, 2024, URL: https://www.scopus.com/ (accessed 11.11.2024).

rently, however, structural shifts have occurred in the global geography of knowledge: at the global level, China surpassed the US in publication output in 2020, while India overtook Germany in 2019 and the UK in 2022; at the macro-regional level, the Indian region nearly matched the Baltic region's publication volume, excluding Russia, in 2024.

Contribution of individual countries to macro-regional research output growth

For the examined macro-regions, Moran's I values were computed over time to evaluate the spatial autocorrelation of publication productivity per 100,000 population (Fig. 3). For most time intervals, negative values were obtained, indicating a dispersed distribution of countries within both macro-regions: the Baltic region and, after 2010, the Indian region. According to the constructed spatial Moran scatterplots, inter-country inequality in publication output within the Indian macro-region increased between 1990 and 2024, while remaining virtually unchanged in the Baltic region.

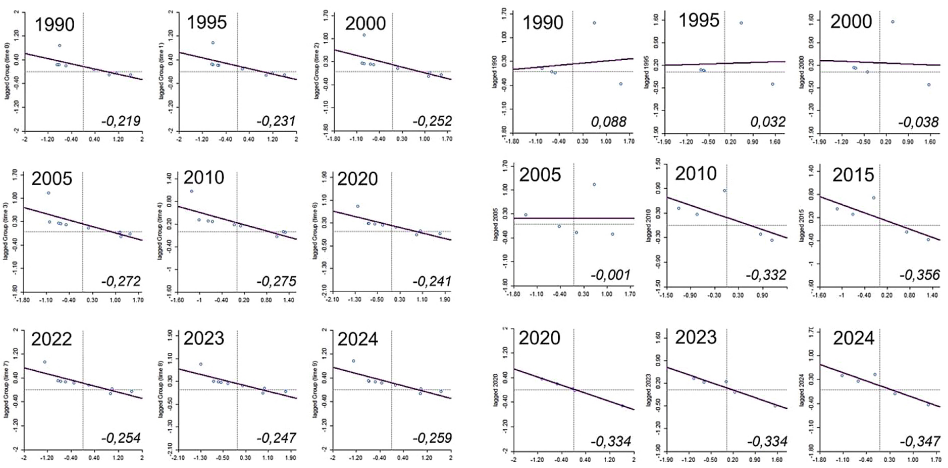


Fig. 3 Moran spatial scatterplots, 1990—2024: *a* — Baltic region; *b* — Indian region

Prepared based on Scopus data,[1] using GeoDa software.

Presented below is an analysis of individual countries' contributions to the macro-regional increase in publication performance and output (see Figs. 4 and 6). In the Baltic region, Germany is the main driver of the absolute growth in the number of research publications. The country ranks fourth worldwide in total research publications between 1990 and 2024 (4.66 million publications, or 6.4 % of the global total), surpassed only by the US, China, and the UK. In the

[1] Scopus, 2024, URL: https://www.scopus.com/ (accessed 11.11.2024).

Indian macro-region, India serves as the leading driver, ranking sixth globally in total publications over the period with 3.38 million publications, or 4.6 % of the worldwide total. Although both Germany and India show annual increases in publication volume, the growth rates differ. India has been expanding its research potential more rapidly year on year, surpassing Germany's publication count by 4.2 % in 2019. By 2023, this lead had increased to 53 %. Thus, in 2023, India entered the top three countries by publication volume, while Germany ranked fifth.

The spatial distribution of knowledge growth within the examined macro-regions is of particular analytical interest. The Baltic region shows less pronounced disparity in the distribution of publication volume among countries compared to the Indian region (see Figs 5 and 6). In different years, Germany accounted for 43 % to 60 % of all publications in the Baltic region, with a population share of 28 %. In contrast, India generated 93 % to 97 % of the Indian region's publications, while accounting for 86 % of its population. For both countries, however, the period under review is marked by a gradual decline in their contribution to the total number of publications across their respective macro-regions against the backdrop of a substantial increase in research output per capita: a threefold increase for Germany and an elevenfold for India.

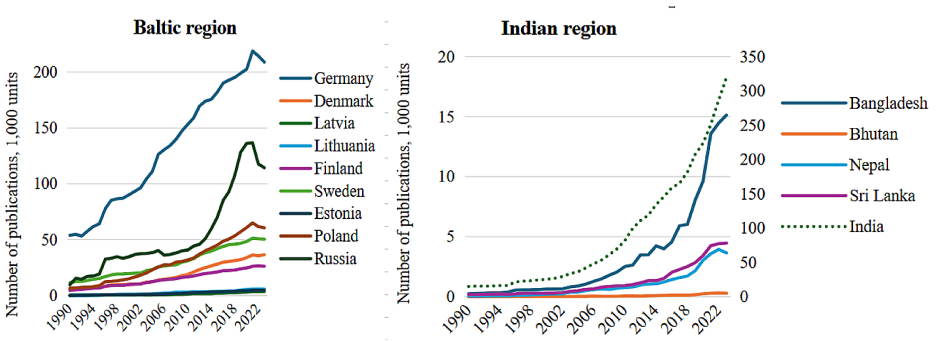


Fig. 4. Changes in the number of research publications in the countries of the Baltic (*a)* and Indian (*b*) macro-regions, 1,000 publications

Prepared based on Scopus data.[1]

Russia is the Baltic region's second-largest centre for research and the world's twelfth, with its share of publications standing at 17.4 % within the macro-region and 2 % globally in 2024. Compared to other Baltic countries, Russia's publication output is relatively modest, at 48.3 publications per 100,000 population. In 2024, this was the lowest figure among the Baltic countries but still higher than in the Indian macro-region, including Russia's strategic partner India, which recorded 19.4 publications per 100,000 population. Notably, following the launch

[1] Scopus, 2024, URL: https://www.scopus.com/ (accessed 11.11.2024).

of the state-run 5—100 academic excellence programme in 2012, aimed at supporting leading Russian universities, Russia experienced a marked increase in international publication output (see Fig. 4). However, since 2021, a reverse trend has been observed, driven by changes in the geopolitical environment and the severance of academic ties with Western countries, including those within the Baltic region.

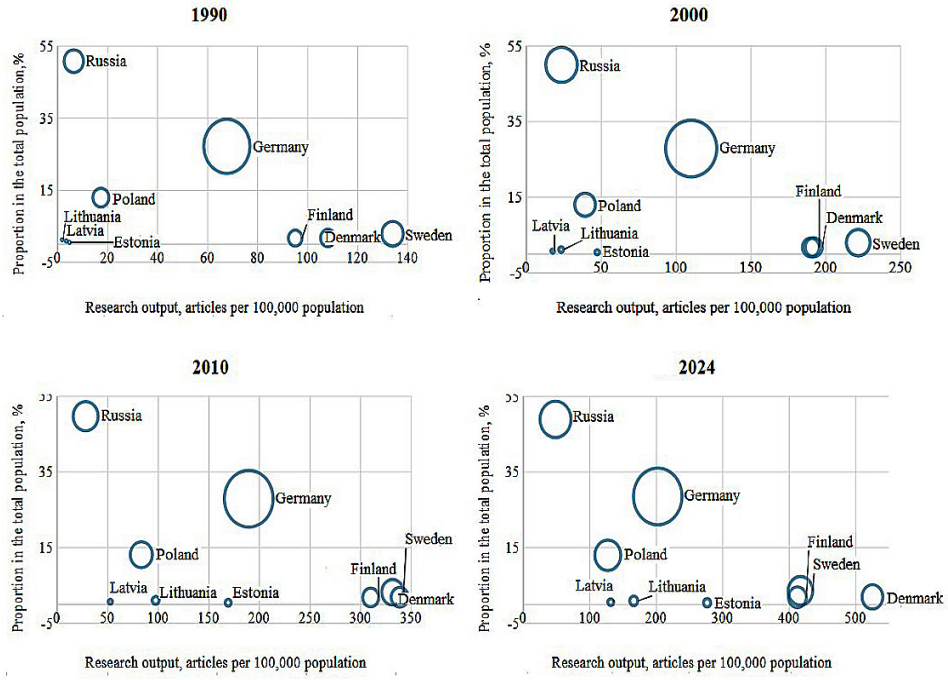


Fig. 5. Distribution of countries in the Baltic region by research output per 100,000 population

Comment: the size of the marker indicates the country's share of research publications within the macro-region, %

Prepared based on data from Scopus[1] and Worldometers.[2]

Poland deserves special mention, having significantly increased its research presence in the macro-region over the past thirty years and now accounting for up to 12 % of all publications in the Baltic region, compared to 7.3 % in 1990. It can be regarded as the macro-region's third-largest centre for research, concentrating considerable human and research potential. However, despite this growth, Poland's research output remains relatively modest at 127 publications per 100,000 population, comparable to Latvia, which lags considerably behind Poland in terms of resources.

[1] Scopus, 2024, URL: https://www.scopus.com/ (accessed 11.11.2024).
[2] Worldometers, 2024, URL: https://www.worldometers.info/ (accessed 11.11.2024).

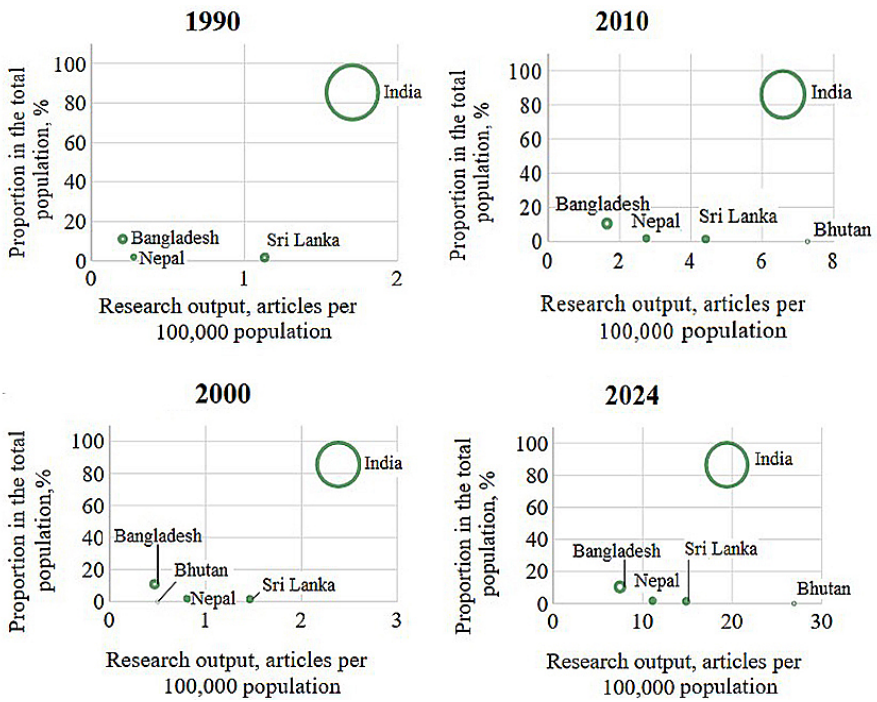


Fig. 6. Distribution of countries in the Indian region by research output per 100,000 population

Comment: the size of the marker indicates the country's share of research publications within the macro-region, %

Prepared based on data from Scopus[1] and Worldometers.[2]

The other countries of the Baltic region can be divided into two groups based on their quantitative contribution to knowledge generation. The first group comprises the Nordic states — Finland, Sweden and Denmark — which have traditionally maintained high levels of research output (over 400 publications per 100,000 population), with an average share of about 8 % of total publications and a population share between 2 % and 3 %. Between 2000 and 2010, Denmark overtook Sweden to become the regional leader in research output, reaching 525 publications per 100,000 population. Despite their relatively small populations, these countries sustain strong research visibility not only within the macro-region but also globally: in 2023, Sweden ranked 22nd, Denmark 29th and Finland 41st worldwide in terms of absolute publication numbers.

The second group includes the Baltics. With between 131 and 276 publications per 100,000 population in 2024, their research performance is rather modest com-

[1] Scopus, 2024, URL: https://www.scopus.com/ (accessed 11.11.2024).
[2] Worldometers, 2024, URL: https://www.worldometers.info/ (accessed 11.11.2024).

pared to their share of the total population of the Baltic region, standing at 1 % and 2 % respectively. Although the Baltic States can be considered peripheral to the region's research landscape, from 1990 to 2024, inequality in publication metrics among these countries increased, with Estonia gradually pulling ahead. By 2024, the country had surpassed both Germany and Poland in terms of research output.

As noted above, India constitutes the core of the Indian region's research system, while the remaining four countries hold peripheral positions. Their share in total publication output remains limited: Bangladesh accounts for 4.3 %, Nepal and Sri Lanka 1.1 % each, and Bhutan 0.1 %. In terms of absolute annual publication numbers, Nepal and Sri Lanka are currently comparable to the Baltic States, whereas Bangladesh exceeds them by an average factor of three. Nevertheless, research output levels in the Indian region remain low, with the vast majority of the population still excluded from the process of knowledge generation.

Eastern and Western paths of Russia's research collaborations

Between 1990 and 2024, Russia significantly increased the intensity of its international research cooperation, resulting in a growing number of research publications. The peak occurred in 2021, when international collaborations involving Russia yielded 30,500 Scopus-indexed publications. Over the past ten years, on average about 22.2 % (or 232,600) of Scopus publications affiliated Russian authors have been the result of cooperation with international researchers. Throughout the study period, countries from the Baltic and Indian regions have been Russia's research partners, although the intensity of this collaboration has varied (Fig. 7).

Overall, from 1990 to 2024, Russia issued 151,900 research publications in collaboration with countries of the Baltic region and 20,200 with countries of the Indian region. Russia's key research partner in the region is Germany, accounting for 68.7 % of all joint publications between Russia and Baltic region states (see Fig. 7). Poland ranks second in terms of collaborative publications (17.9 %), followed by Sweden (14.7 %) and Finland (12.9 %). Denmark and the Baltic States have been the least engaged in published joint research with Russia. India is Russia's main partner in the Indian region, driving the overall publication trend. Between 1990 and 2024, India accounted for 96.6 % of all co-authored publications between Russia and the Indian region, with 75 % of them published in the past decade. The shares of the other countries in the region remain small, with Sri Lanka standing at 5.2 %, Bangladesh 4.1 %, Nepal 2.0 % and Bhutan 0.2 %.

Thus, in each macroregion under consideration, Russia had one key partner, and collaboration with them largely defined the overall trend. Accordingly, research output patterns in the Baltic and Indian regions after 2022 were shaped to a significant extent by shifts in Russia's international collaboration with Germany and India. Between 2021 and 2023, the number of Russia's joint publications

with the Baltic region declined by 49 % (including a 47 % drop with Germany), while collaboration with the Indian region remained stable (including India, with only a −0.2 % change).

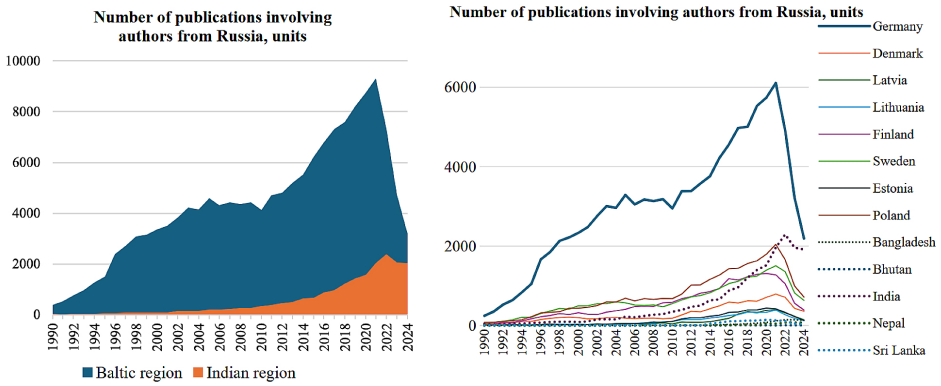


Fig. 7. Changes in the publication of collaboration between Russia and the Baltic* and Indian regions, 1990—2024, number of publications

Comment: *Russia was excluded from calculations for the Baltic region to avoid duplication.

Prepared based on Scopus data.[1]

Figura 8 shows changes in the share of Russia and the countries of the Baltic and Indian regions in each other's publication portfolios.

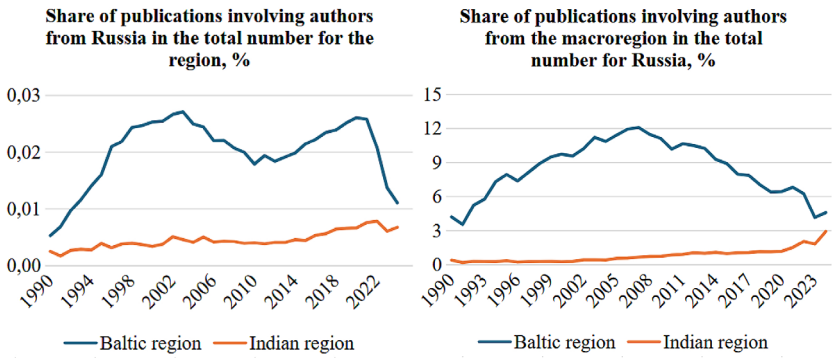


Fig. 8. Mutual contribution of Russia and the Baltic* and Indian regions to each other's publications, 1990–2024, %

Comment: *Russia was excluded from calculations for the Baltic region to avoid duplication.

Prepared based on Scopus data.[2]

[1] Scopus, 2024, URL: https://www.scopus.com/ (accessed 11.11.2024).
[2] Ibid.

It is particularly worth noting that collaborations with Russia account for a rather modest share of the total number of publications in the Baltic and Indian regions — below 0.1 %. This places Russia outside the circle of these states' principal academic partners. Calculating a similar metric to reflect the contribution of countries from the two macro-regions to Russia's total publication output reveals two key points: first, the relatively high significance of these regions for Russia; second, the still dominant position of the Baltic (Western) track of publication collaboration over the Indian (Eastern) one. Since 2008, the share of the Baltic region in Russia's publications has gradually declined, while research cooperation along the Indian track intensified between 2021 and 2024. Accordingly, attributing the decline in Russia's Western collaborations solely to the post-2022 rise in geopolitical tensions would be inaccurate, as this process began much earlier. At the same time, Russia's growing interest in collaborations in the East has become more pronounced, reflected in the rising share of publications with these countries — from 1 % to 3 % in the case of the Indian region.

Conclusions

Spatial scientometric analysis tools provide an effective means to identify and assess macrotrends in the transformation of the global research landscape, as they make it possible to handle large volumes of aggregated bibliometric data within territorially defined boundaries. This study examined changes in the contemporary geography of knowledge production using two macro-regions — the Baltic and Indian — as examples and assessed Russia's role in this process.

Analysis of data on research performance and output demonstrated that the selected macro-regions differ in the spatial distribution of research and their position on the global research map. The Baltic region, which has a well-established role in European and global knowledge production and includes innovation-oriented countries, shows a more balanced distribution of research activity than the Indian region. The study also showed a declining centrality of Germany as the leading research hub in favour of a more distributed structure comprising several centres, complete with a dynamically growing periphery represented by the Baltics.

The Indian region is less balanced, with pronounced disparities in the distribution of research activity. It is dominated by a single country — India — which functions as the sole research centre, surrounded by peripheral states. To a large extent, this paternalistic role of India stems from a shared historical background with its neighbours and reflects the foreign policy course pursued by the Indian state in the second half of the 20th century.

The difference between the macro-regions in the structure of publication activity distribution influences broader publication trends. The annually recorded decline in Germany's contribution to publication output makes the Baltic region's position on the research map of Europe and the world increasingly dependent on the pace of development in the research systems of several other countries. Excluding Russia, these are Poland and the Nordic states. By contrast, the Indian region's research visibility is shaped almost entirely by India's development trajectory.

In this context, the Baltic region's annual contribution to the quantitative growth of knowledge continues to rise, though at a slower pace than that of the Indian region. Most European countries within the macro-region demonstrate high levels of research output, enabling strong publication performance despite smaller population sizes. Each country's research output has an upper limit, beyond which further growth is constrained by the limitations of its research system. In the medium term, a deceleration in the overall growth of research activity is likely for the developed countries of the Baltic region, even as they maintain a high level of research output.

The Indian region follows a catching-up development model characterised by high annual publication growth rates. The findings indicate a shift in the spatial structure of global knowledge growth, with the Indian region significantly improving its position over the past three decades. This study confirms the increasing contribution of the East to knowledge growth, accompanied by greater involvement of eastern countries previously rarely considered attractive international research collaborators.

Russia has historically developed research collaborations with both the Baltic and Indian regions. While the Baltic collaboration path has stagnated, especially over the past decade, reflected in a steadily declining share of joint publications with Russia, the Indian track has yet to reach its full potential despite the declared strategic partnership between Russia and India. This may result from difficulties in establishing academic ties between researchers in both countries, caused by significant cultural and linguistic differences, divergent national research agendas and inconsistent institutional support for cooperation. The recent revival of joint publication activity between Russia and countries of the Indian macro-region appears driven more by geopolitical shifts than by natural processes of evolving academic connections. At the same time, the empirically observed rise of Eastern influence in global research underscores the importance for Russia to continue strengthening academic links with Asian countries. However, predicting the long-term durability of this trend remains challenging. A complete replacement of Russia's network of Western academic partners by Eastern ones

seems unlikely. A more pragmatic approach involves seeking points of convergence along both paths to maintain international research contacts as an element of soft power.

A promising research avenue is the study of a broader range of macro-regions to assess global and regional trends in the redistribution of world centres of knowledge growth and interconnections between these centres. Attention should be given to qualitative characteristics of international research cooperation, including citation metrics, the prestige of academic journals, and the representation of regions and institutions. Relying solely on quantitative methods limits the interpretation of results regarding the specific features of Russia's research collaboration with other countries, including sectoral, regional, and historical aspects. Evaluations of international academic interactions should be expanded by incorporating additional parameters such as patent statistics, academic mobility, intellectual resource migration, and institutional support. A valuable avenue for future research is the qualitative assessment of changes in the geography of knowledge production depending on the research field.

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