

Science Diplomacy in the Implementation by States of the Concept of “Soft Power”

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ANNOTATION. The article considers the forms of development of the concept of public diplomacy, which has become both an effective mechanism for promoting the national interests of states and can be considered as a criterion for stratifying countries by the level of development. It is determined that the high intellectual intensity of scientific and diplomatic activities is the common characteristic that led to their combination at a certain historical stage in the form of science diplomacy as a form of combining the activities of the state and management of national intellectual capital, and which is classified as a leading mechanism for the transmission of soft power by states. The authors demonstrate the relationship between the level of economic development, the volume of expenditures and the effectiveness of efforts to implement the instruments of science diplomacy, the theoretical discourse on which is developing in three key functional dimensions (science in diplomacy, diplomacy for science, and science for diplomacy). It is outlined that the institutionalisation of science diplomacy opens up the possibility of targeted activities to manage the science diplomacy of its actors, as well as to increase the efficiency and effectiveness of this activity. The article summarises the dominant formats of science diplomacy with a focus on the peculiarities of international academic and scientific exchanges, government programmes, international academic mobility, and emergent science and education diplomacy (in the global online education market, world-class universities, international teams of collaborators). The newest institutional forms of competitive interaction between the subjects of science diplomacy are identified, which include platforms for professional cooperation of scientific attaches of different states, scientific, diplomatic and diaspora networks, as well as the institute of technological ambassadors. It is proposed to consider the dominant and newest formats of science diplomacy, as well as joint research infrastructure and practices of hybrid combination of mechanisms and instruments of science diplomacy by states as components of the development of a global model of the international economic order. The authors suggest that developing countries should focus on using the potential of non-institutionalised science diplomats to promote their national interests. It is concluded that the economic potential of science and its international nature are actively manifested in the use of various institutional forms of international academic entrepreneurship and competitive interaction, which are developed and most actively sought to be used by those countries that invest most in research. The article identifies such research subjects as climate diplomacy, food diplomacy and other types of public diplomacy as promising, the development of which is associated with the intensification of research efforts to solve global problems.

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Introduction

Trust and understanding of partners have become crucial attributes and criteria of modern practice in international economic relations. They make it possible to promote trade, attract investment, open market access, integrate and think about joint solutions to global problems. Public diplomacy, as the object of this study, is an important factor in building trust and understanding of partners by promoting transparency and open communication, education and cultural exchange, developing the ethics of official dialogue and solving international and global problems, shared governance and institutional development, responsible investment and sustainable development.

The relevance of this study is due to a number of factors, among which we consider the following to be the most important. *Firstly*, the need to improve the efficiency of the state's implementation of the public diplomacy strategy⁴; *secondly*, to take full advantage of the chance to join the cohort of developed countries through the post-war recovery of the national economy and public administration system; *thirdly*, the desire to maximise the potential of domestic scientists and educators, who are the main carriers of domestic intellectual capital.

The key problem of the development of national science diplomacy for the realisation of national interests is the lack of arguments for its effectiveness and diversity of forms. The lack of efforts to use the potential of scientists and educators to promote national interests on an international scale is due to various reasons, including: the level of development of diplomatic activity; the amount of resources allocated by the state for the development of international cooperation; the quality of strategic documents and the practice of their implementation in the field of national diplomacy; insufficient interaction between public authorities in areas of overlap; low intensity of research in the field of national interests in the global environment; and the lack of research on the implementation of national interests in the global economy.

The solution to these problems is possible through the implementation of a set of interrelated steps. In particular, we are talking about measuring the potential of scientists and educators to promote national interests on an international scale, improving the quality of diplomatic activities, allocating sufficient resources to the development of international cooperation, developing strategic documents taking into account the potential of domestic intellectual capital, improving interaction between public authorities, intensifying qualitative research in the field of implementation of national interests in the

⁴ Kuleba, D., Dzhaparova, E., Lipyatska, M. (2021). *Public Diplomacy Strategy of the Ministry of Foreign Affairs of Ukraine for 2021–2025*. Kyiv: Ministry of Foreign Affairs of Ukraine, 17. URL: <https://mfa.gov.ua/storage/app/sites/1/Сtrparerii/public-diplomacy-strategy.pdf>. [In Ukrainian]

global space, and strengthening the interaction of public services. In order to enable them in the context of this study, it is advisable to summarise the most important features of the components of science diplomacy development, the use of which is a characteristic feature of developed countries.

Therefore, the purpose of the study is to comprehensively summarise the characteristics of the key forms of science diplomacy deployed by developed countries. To achieve this, a number of tasks have been set, namely: to analyse recent publications on the development of public diplomacy and science diplomacy as its type; to study approaches to defining the concept of public diplomacy; to reveal the existing and identify the latest institutional framework and dominant formats for the development of public diplomacy; to propose vectors for the development of public diplomacy in Ukraine.

Science diplomacy: a theoretical and practical concept

The end of the Cold War and the destruction of the bipolar system of international order in the early 1990s resulted not only in the formation of a qualitatively new subjective structure of economic diplomacy of states, but also in the diversification of the instruments and principles of diplomatic activity used by them, a significant complication of interstate political interaction, and a considerable increase in the influence of non-state actors in international relations on the global agenda. Under such conditions, the political and economic landscape of sovereign states is undergoing fundamental transformations, increasingly «drifting» towards a certain weakening of their national sovereignty and «blurring» the traditional functional separation of foreign and domestic policies.

The synergistic effect of these global imperatives in the last three decades has given a powerful impetus to the development of all structural subsystems of diplomatic activity of states – from economic and military diplomacy to humanitarian, parliamentary, sports, environmental, expert, cultural, digital and – especially – *science diplomacy*. It is the latter that J. Melissen and J. Nye very accurately qualify in the modern Western theoretical discourse of diplomatic activity as the *leading mechanism for the transmission of soft power by states*^{5, 6}. It is implemented through official and unofficial channels and is aimed at achieving their own foreign policy and foreign economic goals by attracting foreign audiences and shaping their positive image in the eyes of the world community. The steadily growing interest of the global scientific community in the issues of science diplomacy and its decisive role in the realisation of national interests by states is evidenced, in particular, by the

⁵ Melissen, J. *The new public diplomacy: soft power in international relations*. Basingstoke, Palgrave Macmillan, 2005. p. 70

⁶ Nye, J. S. *Soft Power: The Means to Success in World Politics*. New York, Public Affairs, 2004. p. 107

fact that *the ProQuest Dissertation & Theses Global* database⁷ has accumulated over 5.2 thousand dissertations on science diplomacy over the entire period of its existence, including 4.2 thousand over the past ten years, and 400⁸ in the past twelve months⁹.

An analysis of the use of the selected keywords in the most cited 400 publications out of 1466 available in the Scopus scientometric database allowed us to build a network of keyword relationships between them (Fig. 1). In this case, the key phrase was «science diplomacy»¹⁰. This visualisation demonstrated both the almost equal frequency of use of the concepts of «science diplomacy» and «diplomacy», followed by «foreign policy» and «international cooperation» and «diplomatic relations», and the fact that they head the clusters of the most used keywords. The two clusters covering the categories of «human» and «global health» are somewhat separately represented, which gives grounds to suggest that health diplomacy should be separated into a separate field of research and international relations. Therefore, the most commonly studied areas along with science diplomacy include public diplomacy, climate change and environmental policy, geopolitics, the United States and China, soft power and approaches to governance.

In recent years, there has been a growing interest in diplomacy as a mechanism to support the realisation of Ukraine's national economic interests. Previously, we have already studied the issues of evaluation models, national peculiarities and diversity of activity and institutional forms of public diplomacy on the example of educational diplomacy¹¹, as well as revealed the functions of public diplomacy¹². At the current stage of development of science in this area, most researchers rely on descriptive methods. Most of the papers in the field of public diplomacy can be divided into two groups: studying the experience of other countries and institutions and in-depth analysis of certain types of public diplomacy. The first group includes works by N. Yakovenko and H. Piskorska, who studied NATO¹³, L. Khorishko – Europe¹⁴, T. Pavlova and V. Shamraeva – the USA¹⁵,

⁷ ProQuest Dissertation & Theses Global. ProQuest. URL: <https://www.proquest.com/resultsol/29314D0B86924860PQ/1#> (accessed 13.10.2023).

⁸ As of December 2023 (author's note).

⁹ ProQuest Dissertation & Theses Global is the most comprehensive global collection of transdisciplinary dissertation and thesis research, with over 5 million citations and 3 million full-text works from thousands of universities worldwide (author's note).

¹⁰ In fact, several alternative variants of its use have been used in English-language scientific periodicals, namely «science diplomacy», «science and diplomacy», «scientific diplomacy» (author's note).

¹¹ Ilnytskyi, D. (2014). Socio-economic dimension of educational diplomacy: theory, practice and methods of analysis. *Strategy of development of Ukraine*, (1). C.72–80. [In Ukrainian]

¹² Ilnytskyi, D. O. (2017). The educational dimension of cultural diplomacy: the issue of economic priorities. *Cultural Almanac*, No. 5, pp. 40–43. [In Ukrainian]

¹³ Yakovenko, N., & Piskorska, G. (2018). The transformation of NATO public diplomacy. *American History and Politics*, (5), 197–206.

¹⁴ Khorishko, L. S. (2022). Public Diplomacy of Ukraine in the Context of Modern Political Reality. *Politikus*. 2022. Issue 3. P. 60–64 URL: <http://dspace.pdpu.edu.ua/bitstream/123456789/16412/1/Khorishko%20Liliia%20Serhiivna.pdf> [In Ukrainian]

¹⁵ Pavlova, T. S., & Shamraeva, V. M. (2017). Instruments of public diplomacy of the United States. *Politikus*. Issue 6. 2017. C. 142–146 [In Ukrainian]

V. Klymonchuk and V. Marchuk – Arab countries¹⁶, N. Zemziulina and M. Zakharchenko – global experience¹⁷. The second group includes the works of Pavlikha N. and Shuliak A., who studied the security of sustainable development¹⁸, Sharov O. – economic diplomacy¹⁹ Panina I. and Parchevska V. – fashion diplomacy²⁰. Foreign scholars focus more on the definition of categories, narrow issues and applied aspects of the implementation of public diplomacy tools, for example, Armstrong M. focused on operationalisation²¹, Ayhan K., Gouda M. and Lee H. on scholarships²², Manfredi-Sanchez J. on vaccine diplomacy²³, Yeo A. and Gloria E. on national identity²⁴.

Providing an economic basis for a number of concepts has led to the emergence of the interdisciplinary category of *science diplomacy*. This is primarily the concept of intellectual capital, which covers all types of human intellectual results that can serve to create added value on a national, regional or global scale. The use of scientific achievements to improve diplomatic activities has led to the emergence of public diplomacy, which now has a wide variety of forms (cultural, scientific, educational, sports, food and culinary, digital, medical, etc.) Moreover, some scholars, in particular P. Griset, argue for the expediency of distinguishing innovative diplomacy as one that is based on a combination of traditional diplomatic practices in the fields of science, technology, economics and culture²⁵. However, the thing that unites almost all types of public diplomacy is the economic dimension, which consists in the need to take into account economic laws in their implementation, as well as the expediency of identifying the components of the value chain, which leads to the formation of competitive advantages of actors through the implementation of public diplomacy tools.

¹⁶ Klymonchuk, V. Y., & Marchuk, V. V. (2022). Subjects of public diplomacy of Ukraine in Qatar, Kuwait and the United Arab Emirates. *Bulletin of NTUU «KPI» Political Science. Sociology. Law*, (3 (55)), 61–68. [In Ukrainian]

¹⁷ Zemziulina, N. I., & Zakharchenko, M. V. (2021). Institutionalisation of public diplomacy: world and Ukrainian experience. *International Relations: Theoretical and Practical Aspects*, (8), 8–22. doi: <https://doi.org/10.31866/2616-745x.8.2021.248185>. [In Ukrainian]

¹⁸ Pavlikha, N., & Shulyak, A. (2022). Public diplomacy for the security of sustainable development. *International Relations, Public Communications and Regional Studies*, (2 (13)), 173–186. [In Ukrainian]

¹⁹ *Economic Diplomacy: Fundamentals, Problems and Prospects*: monograph / O. Sharov ; National Institute for Strategic Studies. Kyiv : NISS, 2019. 560 c. [In Ukrainian]

²⁰ Panina, I. G., & Parchevskaya, V. V. (2021). Fashion industry in public diplomacy of Ukraine and the Republic of Poland: a comparative analysis. *Regional Studies*. 2021. С. 140–147. DOI <https://doi.org/10.32782/2663-6170/2021.24.20> [In Ukrainian]

²¹ Armstrong, M. C. (2020). Operationalising public diplomacy. In *Routledge handbook of public diplomacy* (pp. 82–95). Routledge.

²² Ayhan, K. J., Gouda, M., & Lee, H. (2022). Exploring global Korea scholarship as a public diplomacy tool. *Journal of Asian and African Studies*, 57(4), 872–893.

²³ Manfredi-Sánchez, J. L. (2023). Vaccine (public) diplomacy: legitimacy narratives in the pandemic age. *Place Branding and Public Diplomacy*, 19(3), 398–410.

²⁴ Yeo, A., & Gloria, E. (2023). National identity and the limits of Chinese public diplomacy in the Philippines. *Journal of Contemporary China*, 32(139), 35–53.

²⁵ Griset, P. (2020). Innovation diplomacy: a new concept for ancient practices? *The Hague Journal of Diplomacy*, 15(3), pp. 383–397.

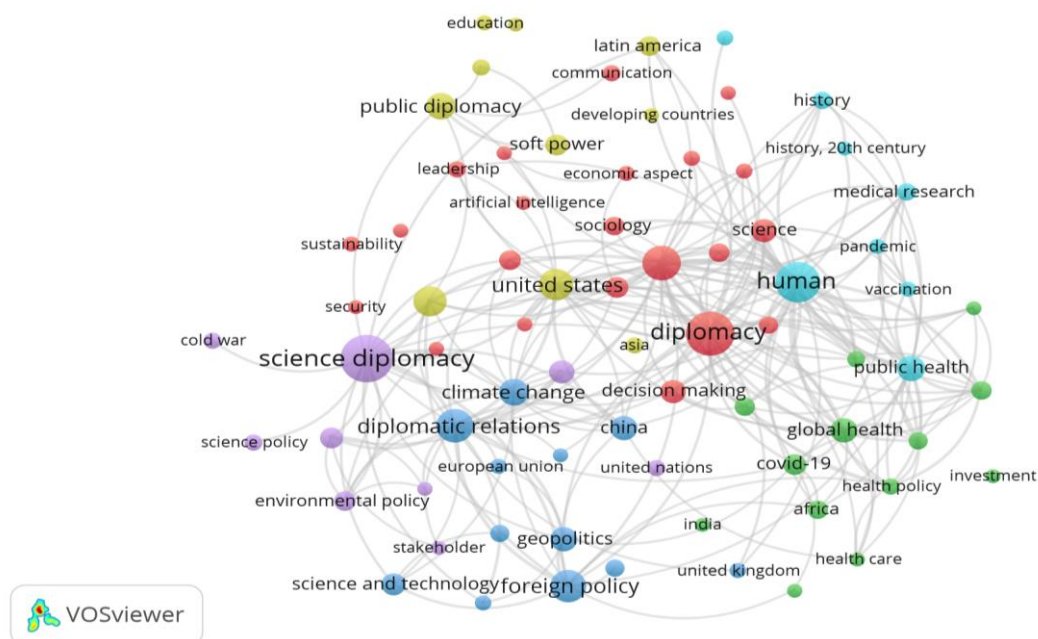


Fig. 1 Network of keywords on science diplomacy

Source: compiled using VOSviewer software according to Scopus data

It is worth noting that the Western theoretical discourse on science diplomacy has been based in the last decade on the conceptual understanding of *its three key functional dimensions*, clearly formulated in 2011 by the American Association for the Advancement of Science (AAAS) and the *Royal Society* of London. These are, **firstly**, *science in diplomacy*, which involves the use of scientific knowledge to support the foreign policy of states; **secondly**, *diplomacy for science* – comprehensive diplomatic support for international scientific and technological cooperation; **thirdly**, *science for diplomacy* – the widespread use of various interstate scientific alliances to improve the effectiveness of foreign policy and foreign economic cooperation of countries and bring it to a qualitatively higher level of development²⁶. As we can see, all these areas of science diplomacy in their entirety actually reflect, on the one hand, the special status of science as a social integrator and the main driver of the institutional organisation of global development; and on the other hand, all aspects of cooperative and co-opetition (despite the fierce and unrelenting competition for technological and innovative

²⁶ New frontiers in science diplomacy. Navigating the changing balance of power. AAAS – *The Royal Society*, January 2010. URL: https://www.aaas.org/sites/default/files/New_Frontiers.pdf (accessed 24.10.2023).

leadership) activities of states in solving the most pressing problems of humanity today through the development of an open science ecosystem in the global coordinates.

Despite a certain «blurring» of the categorical identification of science diplomacy and international scientific and technological exchange due to their deep convergence, international nature and inability to develop in isolation, the latter can qualify as a scientific and diplomatic practice only if its mechanisms are fully subordinated to the goals of realising national interests by states. The point is that, although joint scientific, technical and innovative activities of international teams of scientists can be carried out on commercial terms, their transformation into science diplomacy occurs only if its tools are used by states to build up their soft power, prevent or resolve interstate conflicts, and as an integral component of the system of global governance of socio-economic processes.

Thus, by combining the political course of states, their scientific, technological and innovative resources, science diplomacy is aimed, as Canadian researcher D. Copeland emphasises, at «solving the *most pressing problems of the planet ... and ... cross-border transfer of core human values such as evidence-based learning, cooperation, openness and exchange*»²⁷. In turn, former US Secretary of State Hillary Clinton emphasises that «*science diplomacy and scientific and technological cooperation between the United States and other countries is one of the most effective ways to increase American influence on other countries and build genuine bridges between the United States and its partners*»²⁸.

It is no coincidence that the founders, ideological inspirers and consistent implementers of the global science diplomacy movement since the second half of the 1950s have been the United States of America, which has since then been steadily increasing its political and diplomatic leadership in the world with all the scientific, technological and innovative practices available in its arsenal. Moreover, the very historical logic of this country's implementation of science diplomacy mechanisms at all stages of its evolutionary development over more than a century has always reflected the US strategic goals of establishing its economic and political hegemony around the world and shaping key innovative megatrends of global economic development.

Moreover, it is the United States of America that currently concentrates the lion's share of the global intellectual elite on its territory, has the world's largest research resource (especially in the field of fundamental research) and is unattainable for any other country in the world in terms of infrastructure

²⁷ Copeland D. Science Diplomacy: What's It All About? *CEPI-CIPS, Policy Brief*, 2011. No. 13. P. 1–4. URL: <https://www.cips-cepi.ca/wp-content/uploads/2011/11/Copeland-Policy-Brief-Nov-11-5.pdf>.

²⁸ Lijesevic J. Science Diplomacy at the heart of international relations. *E-International Relations*, 01.04.2010. URL: https://www.e-ir.info/2010/04/01/science-diplomacy-at-the-heart-of-international-relations/#_ftn2 (accessed 14.10.2023).

capabilities to control the global information space. The United States spends enormous amounts of money on research and development, has developed an extremely effective system of training scientific personnel, and has turned its educational system into a successful business project and an effective channel for attracting intellectual capital in the form of the most educated and qualified professionals from around the world. In support of this thesis, we cite, in particular, the following data: the total number of American Nobel Prize winners as of 2023 is 400²⁹ (or 35.3 % of the world’s³⁰); in 2022 alone, the United States spent \$679 billion on research and development (R&D)³¹. The total number of researchers in this country now reaches almost 1.8 million people (Table 1); and the annual value of funding for basic research in its academic (university) sector increased from 0.3 to 89.9 billion US dollars in 1953–2021. USA³².

Table 1

KEY INDICATORS OF SCIENTIFIC, TECHNOLOGICAL
AND INNOVATIVE DEVELOPMENT OF COUNTRIES IN 2021

Country	Total R&D expenditure		Technology balance, billion USD		Total number of researchers, thousand people	High-tech exports, billion USD	Total number of scientific publications***, thousand**
	billion USD	% of GDP	receipts	payments			
Austria	17,5	3,3	1,7	1,8	56,5	21,3	27,3
Belgium	23,4	3,4	4,1	3,2	76,2	52,2	34,6
Canada	34,4	1,7	8,5	16,6	191,7	29,1	121,1
China	667,6	2,4	11,7	46,8	2 281,1	942,3	744,0
Denmark	10,7	2,8	4,5	1,7	45,0	12,4	29,9
Finland	9,1	3,0	3,4	1,1	43,6	5,5	21,8
France	77,2	2,2	15,3	13,1	333,8	97,5	112,8
Germany	153,7	3,1	58,5	20,3	461,6	209,7	174,5

²⁹ This is followed by the United Kingdom with 137 Nobel Prize winners, Germany – 111, France – 71, Sweden – 32, Japan – 29, Canada – 28, Switzerland – 27, Austria and the Netherlands – 22 each as of 2023. See: Nobel Prize Winners by Country. *Wisevoter*. URL: <https://wisevoter.com/country-rankings/nobel-prize-winners-by-country/> (*author’s note*).

³⁰ Nobel Prize Winners by Country. *Wisevoter*. URL: <https://wisevoter.com/country-rankings/nobel-prize-winners-by-country/>.

³¹ Source. Calculated by the author according to [Total global spending on research and development (R&D) from 1996 to 2022 (in billion PPP U.S. dollars). Statista. The Statistical portal. URL: <https://www.statista.com/statistics/1105959/total-research-and-development-spending-worldwide-ppp-usd/>].

³² *Higher Education Research and Development: Fiscal Year 2021*. Data Tables. NSF 23-304. National Centre for Science and Engineering Statistics. December 15, 2022. pp. 10–11. URL: <https://nces.nsf.gov/surveys/higher-education-research-development/2021> (accessed 13.10.2023).

Completion of the table 1

Country	Total R&D expenditure		Technology balance, billion USD		Total number of researchers, thousand people	High-tech exports, billion USD	Total number of scientific publications***, thousand**
	billion USD	% of GDP	receipts	payments			
Ireland	6,1	1,1	18,2	133,0	26,1	42,5	16,6
Italy	40,1	1,5	4,9	5,1	158,9	38,9	127,5
Republic of Korea	119,6	4,9	8,1	11,1	470,7	163,9	91,1
Japan	177,4	3,3	48,2	29,5	704,5	116,5	127,4
Luxembourg	0,9	1,0	2,7	8,8	3,1	0,8	2,3
Netherlands	25,7	2,3	23,2	17,7	106,1	101,2	62,5
New Zealand	3,6	1,5	1,2	1,1	26,0	1,1	16,9
Norway	8,6	1,9	0,4	0,6	38,9	4,7	25,2
Spain	20,6	1,4	3,8	5,9	154,1	23,5	104,4
Sweden	21,4	3,4	8,9	10,9	84,7	18,9	43,3
Switzerland	22,2	3,4	30,7	33,6	52,2	38,2	47,6
United Kingdom	97,8	2,9	24,7	17,2	295,8	66,7	198,5
USA	679,4*	3,5	124,6	43,3	1 797,6	169,2	624,6
Global indicator	2 348,2	2,3	434,7	508,8	5 670,7	2853,6	4236,3

* – data for 2022; ** – data for 2020; *** – publications in English

Source: compiled by the authors based on ^{33, 34, 35, 36}.

It is worth noting that the lion's share of these allocations for scientific activities currently comes from federal sources (49.2 billion US dollars, or

³³ Main Science and Technology Indicators. OECD. Stat. URL: https://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB (accessed 24.10.2023).

³⁴ *United States Number of Researchers: Total*. CEIC. URL: <https://www.ceicdata.com/en/united-states/number-of-researchers-and-personnel-on-research-and-development-oecd-member-annual/number-of-researchers-total> (accessed 23.10.2023).

³⁵ *World Development Indicators: Science and technology*. The World Bank. URL: <https://wdi.worldbank.org/table/5.12> (accessed 22.10.2023).

³⁶ Leading countries by gross research and development (R&D) expenditure worldwide in 2022 (in billion U.S. dollars). *Statista. The Statistical Portal*. URL: <https://www.statista.com/statistics/732247/worldwide-research-and-development-gross-expenditure-top-countries/>.

54.7 % of total funding at the end of the period³⁷), which are allocated through an extensive network of national research institutions and agencies systematically involved in the implementation of the US government’s diversified science diplomacy tools. Among them, the following deserve the most attention: The Department of Defence (which in 2022 alone received USD 62.8 billion in research funding), the Department of Health and Human Services (HHS) (51.2 billion); the Department of Energy (21.5 billion), NASA (14.6 billion), the National Science Foundation (8.2 billion); the Departments of Agriculture (3.6 billion), Commerce (2.7 billion), and Transportation (1.3 billion, respectively)³⁸ and others. The annual amount of federal funding for these areas of R&D increased from USD 127.3 billion to USD 191.5 billion in 2017–2023. The average annual growth rate of expenditures was 4.8 % in 2017–2023 (Table 2). Such a structural distribution shows the crucial role of the budgetary mechanism in the implementation of the US science diplomacy, which currently represents one of the most important financial directions of its state policy in this area.

Table 2

US FEDERAL SPENDING ON RESEARCH AND DEVELOPMENT BY SELECTED CATEGORIES OF BUDGETARY FUNCTIONS, USD billion

Cost categories	2017	2018	2019	2020	2021	2022	2023 (planned)	Share in the structure for 2017–2023, %	average annual growth rate in 2017–2023, %
In total	127,3	144,5	150,0	169,9	165,6	179,4	191,5	46,9	4,8
National defence	57,5	69,0	72,0	81,9	79,6	78,7	90,1	53,1	5,2
Non-defence sector, including:	69,8	75,5	78,0	88,0	86,0	100,7	101,4	8,5	4,5
- General science and basic research	11,3	12,6	13,2	13,7	13,8	15,4	16,0	7,5	4,2

³⁷ *Higher Education Research and Development: Fiscal Year 2021. Data Tables.* NSF 23-304. National Centre for Science and Engineering Statistics. December 15, 2022. p. 11. URL: <https://nces.nsf.gov/surveys/higher-education-research-development/2021> (accessed 13.10.2023).

³⁸ Federal research and development funding requests in the United States for fiscal year 2022, by government agency (in million U.S. dollars). *Statista. The Statistical Portal.* URL: <https://www.statista.com/statistics/1322983/federal-research-development-funding-agency-us/> (accessed 26.10.2023).

Completion of the table 2

Cost categories	2017	2018	2019	2020	2021	2022	2023 (planned)	Share in the structure for 2017–2023, %	average annual growth rate in 2017–2023, %
- Space flights, research and support activities	10,2	10,6	10,1	14,2	12,6	13,8	12,8	3,2	2,9
- energy	3,5	4,2	4,5	4,5	4,5	6,5	9,3	2,0	8,9
- Natural resources and the environment	2,5	2,7	2,8	2,9	2,9	3,8	4,7	1,7	6,7
- agriculture	2,3	2,3	2,7	2,7	2,7	3,2	3,5	1,1	4,9
- transport	1,5	1,6	1,6	1,7	1,7	2,0	2,2	26,4	4,5
- healthcare	34,4	37,3	39,0	44,4	43,5	51,2	48,3	0,9	4,1
- benefits and services for veterans	1,3	1,3	1,5	1,4	1,4	1,6	1,7	1,8	3,4
- other	2,8	2,9	2,6	2,5	2,9	3,2	2,9	46,9	0,5

Source: calculated and constructed by the authors based on data from ³⁹, ⁴⁰.

Institutionalisation of science diplomacy

Under current conditions, it can be argued that the theory and practice of science diplomacy have passed the period of initial institutionalisation, which is necessary for science to fulfil its economic function and manage it. Therefore, the leading states are now asking themselves how to improve the efficiency of the functioning of certain institutions, and developing countries are trying to involve new actors in diplomatic activities. The internationalisation of science is considered to have virtually taken place

³⁹ Boroush M. *Sizable Growth in Federal Budget Authority for R&D Evident for the FYs 2017-21 Period; Further Increase Proposed for FY 2022*. National Centre for Science and Engineering Statistics. pp. 1–2. URL: <https://ncses.nsf.gov/pubs/nsf22322/assets/nsf22322.pdf> (accessed 22.10.2023).

⁴⁰ Pece, C. V. *Federal budget authority for R&D and R&D plant, by budget function, ordered by FY 2020 R&D and R&D plant total: FYs 2021-23* (Millions of dollars and percent change). National Centre for Science and Engineering Statistics. URL: <https://ncses.nsf.gov/pubs/nsf23323/assets/nsf23323.pdf> (accessed 22.10.2023).

everywhere and to be pushing scientists to use various institutional forms of international academic entrepreneurship⁴¹.

Let us specify the key *actors of science diplomacy*. They are represented by a wide range of market participants – from individuals involved in various kinds of international educational, scientific and cultural interactions at *the P2P (person-to-person)* level to professional diplomats and scientists, civil servants and embassy staff, science policy managers and political scientists, public relations specialists and numerous institutional actors represented by organisations of various departmental. A key role in the subjective structure of science diplomacy is played by diplomatic representations of states (embassies and consulates) as active centres of science diplomacy, which, being located in foreign countries, use a wide range of its instruments at the bilateral level through the appointment of scientific advisers and attachés, as well as systematic support for the development of international research and innovation networks.

Actors of science diplomacy can *acquire* both *institutionalised* and *non-institutionalised status*⁴², depending on their organisational configuration, specificity of professional activity and functional profile. As for the institutionalised science diplomats, their group is represented by staff members of embassies (primarily science attaches) and foreign ministries, ministries and government agencies, research councils and international organisations, scientific consultants and advisers to senior government officials who have the appropriate official mandates to conduct professional activities in the field of science diplomacy. For example, the United Kingdom and the United States of America were pioneers in establishing the posts of scientific attaches at embassies back in the 1960s, and today the global leaders in terms of their number are France (50 people), China (46), the United States (33), the United Kingdom (29), Canada (25) and Japan (25)⁴³.

On the other hand, the group of non-institutionalised science diplomats includes non-governmental actors who, in carrying out the functions of science diplomacy, act through non-governmental, informal and unofficial channels, interacting only occasionally with governmental and public officials. First and foremost, we are talking about the research staff of educational and scientific institutions, who, working closely with politicians and full-time diplomats, relay the results of their scientific research to society, public policy and international relations. It should be emphasised that scientific diplomats of the non-institutionalised segment currently have

⁴¹ Krabel, S., Siegel, D. S., & Slavtchev, V. (2012). The internationalisation of science and its impact on academic entrepreneurship. *The Journal of Technology Transfer*, 37, 192–212.

⁴² Melchor L. (2020). What is a science diplomat? *The Hague Journal of Diplomacy*, 15(3), 409–423. URL: https://brill.com/view/journals/hjd/15/3/article-p409_11.xml (accessed 15.10.2023).

⁴³ Zagitova K. *Science diplomacy is gaining soft power*. Institute for Statistical Research and Knowledge Economy. 9 March 2017. URL: <https://issek.hse.ru/news/203621872.html>.

the greatest resource capacity to build a wide range of problem-oriented interstate partnerships. This greatly facilitates the coordination of international science and technology policy on a variety of issues – from supranational standardisation of professional qualification requirements for scientists to the implementation by states of unified approaches to the development of national scientific potential and the building of a global innovation ecosystem.

The role of science in diplomacy

When studying the nature of science, it should be emphasised that its impartiality against the background of a generally high level of diplomatic involvement may even give rise to a misconception of science diplomacy as a rather eclectic process, loosely connected with the imperative influence of science on the foreign policy of states, on the one hand, and the influence of state institutions on scientific activity, on the other. The real situation is quite the opposite, as science diplomacy, covering much broader interests than the scientific ones, is actively used by states today to stimulate macro-economic growth, develop regional and local communities, as well as to achieve their diplomatic goals and promote their own national interests in the international arena on the basis of a deep convergence of research and diplomatic practices. As an example, let us cite the Soyuz-Apollo Space Cooperation Programme, which in the late 1960s was able to become an institutional platform that significantly defused political tensions between the United States and the former Soviet Union, while other diplomatic measures failed to work. It was thanks to this programme that by 1975 it was possible to stabilise relations between the two centres of the bipolar system of the international order to some extent, convincingly proving the wide possibilities of establishing mutually beneficial and effective interstate cooperation even in the face of sharp economic, cultural and ideological confrontation⁴⁴.

Another eloquent example that confirms the extremely important role of science in the diplomatic activities of various states is the *jointly established research infrastructures* such as the *Large Hadron Collider (LHC)* of the European Organisation for Nuclear Research (1998–2008) or the independent laboratory SESAME (Synchrotron Light for Experimental Science and Applications in the Middle East) created under the auspices of UNESCO in Jordan with the participation of Bahrain.) or the independent laboratory SESAME (*Synchrotron-Light for Experimental Science and Applications in the Middle East*) established under the auspices of UNESCO in Jordan with

⁴⁴ Krasnyak O. The Apollo-Soyuz Test Project: Construction of an Ideal Type of Science Diplomacy. *The Hague Journal of Diplomacy*. 2018. No. 13. P. 410–431.

the participation of Bahrain, Cyprus, Egypt, Iran, Israel, Pakistan, the Palestinian Authority and Turkey (2002) to promote peace between the Middle East states. At the same time, the *practice of hybrid combination of mechanisms and instruments of science diplomacy by different states* is quite common, which makes it possible to significantly increase their effectiveness and adaptability to the requirements and needs of specific partner states.

It should be noted that the current stage of development of the global model of the international economic order is characterised by the dynamic internationalisation of scientific activity. This fact guides the international community to *fundamental changes in the dialectical paradigm of science diplomacy in order to maximise its adaptation to numerous endogenous (local, regional, national) and exogenous (global) processes that reinforce each other*⁴⁵. As a result, everyone is currently witnessing a *significant increase in the resource capabilities of international science through the diversification of bilateral and multilateral, cross-border and regional scientific and technological cooperation*, which ensures not only the deepening of interstate scientific, technical and innovative cooperation, but also a high level of its adaptability to the impact of techno-globalisation imperatives.

At the same time, the main purpose of the subjects of scientific activity should be taken into account. For diplomats, it is the professional promotion of national interests, and for scientists, it is the conduct of scientific activities on the basis of autonomy. This is what makes it expedient to combine their potentials for the use of soft power.

Forms of materialisation of science diplomacy

The intensification of academic entrepreneurship and the internationalisation of higher education institutions and the markets in which they operate, as well as the diversification of their missions and strategic goals, give rise to new and evolving forms of interaction between researchers, educators and students. As for the *dominant formats of science diplomacy*, they have undergone significant diversification in recent decades and now include a wide range of international interactions, namely academic and scientific exchanges, international publishing activities of scientists from different countries, export of educational and scientific services, financing of scientific projects by various foundations, involvement of scientists and experts from different countries in the preparation of foreign policy decisions on the most pressing issues of global development (environmental protection, education, healthcare, international security, Arctic development, etc;)

⁴⁵ *Science diplomacy in the Arctic: platforms, practices, new challenges* / Yu. V. Zaika, L. A. Riabova, A. A. Sergunin; under the scientific editorship of L. A. Riabova, Y. V. Zaika. Apatity: Publishing House of FRC KSC RAS, 2023. pp. 8.

participation of scientists in the implementation of international technical assistance programmes; creation of structural units in foreign diplomatic missions with functional powers in the field of international scientific and technological development, etc.

With regard to the dialectic of *international academic and scientific exchanges*, in recent decades they have become a well-established channel for shaping a positive image of host countries in the eyes of exchange project participants by demonstrating the achievements of their national education and science systems, competitive advantages of the state system, and spreading their ideals and values among the target audience. In our opinion, these are the powerful positive externalities of science diplomacy in the implementation by donor countries of international academic and scientific exchanges of their national interests in global coordinates. Describing this kind of externalities, J. Nye emphasises that: «*academic and scientific exchanges have played an extremely important role in strengthening US soft power. While some American sceptics feared that Soviet scientists and agents of the USSR's State Security Committee would «blind» us, they did not notice that when they came to the United States, along with scientific secrets, they also absorbed political ideas*»⁴⁶.

Thus, one of the most effective institutional platforms for the implementation of large-scale international academic and scientific exchanges for more than a century has been the United States Department of State. The scale of funding for scientific and educational exchanges achieved by the US Department of State today is evidenced by the fact that in 2013–2021, their annual volumes increased from USD 574 to 740 million. This consistently exceeds 30–35 % of the total amount of public funding for US public diplomacy (USD 2.1 billion in 2021)^{47, 48}. It is worth noting that among all the units of the Department of State involved in the implementation of scientific and diplomatic activities, the Bureau of Educational and Cultural Exchanges is the undisputed leader in terms of the share in the total budgetary funding of the Department of State (with the exception of the US Global Media Agency). Over the 80 years of its existence, more than 230,000 American citizens have benefited from its programmes, and another 4.4 million foreign participants have visited the United States through *BridgeUSA's* academic, educational, and cultural

⁴⁶ Nye J. S. *Soft Power: The Means to Success in World Politics*. New York, Public Affairs, 2004. p. 45.

⁴⁷ *2017 Comprehensive Annual Report on Public Diplomacy & International Broadcasting. Focus on FY 2016 Budget Data*. The United States Advisory Commission on Public Diplomacy (ACPD). 2017. pp. 12. URL: https://www.academia.edu/34696741/2017_Comprehensive_Annual_Report_on_Public_Diplomacy_and_International_Broadcasting.

⁴⁸ *2022 Comprehensive Annual Report on Public Diplomacy & International Broadcasting. Focus on FY 2021 Budget Data*. The United States Advisory Commission on Public Diplomacy (ACPD). 2022. p. 2. URL: https://www.state.gov/wp-content/uploads/2022/12/FINAL_2022_ACPD_AnnualReport_508Ready.pdf (accessed 27.10.2023).

exchange programmes. Graduates of such programmes are now key partners of the United States in achieving its strategic foreign policy goals, as they return to their homeland with favourable views on US international policy, market skills and experience in further building their careers. Suffice it to say, 42 of them are current members of the US Congress, 656 are current and former heads of state and national governments, and 86 are Nobel Prize winners.

This is the reason why, of all the programme areas of the US Bureau of Educational and Cultural Exchanges, academic exchange programmes currently receive the largest funding, with a share ranging from a minimum of 55.2 % of the total ECA budget in 2022 to a maximum of 56.8 % in 2020 (Table 3). According to official data, in 2022, the Department of State funded, implemented, or coordinated fifty exchange programmes for foreigners, including 15 academic exchanges and 35 civilian exchanges. Ten of the academic exchange programmes were for high school students, six for bachelor’s students, and two for master’s and PhD students⁴⁹.

Table 3

BUDGET ALLOCATION OF THE US BUREAU OF EDUCATIONAL AND CULTURAL EXCHANGES BY PROGRAMME AREAS, USD million

Areas of programme activity		2018	2019	2020	2021	2022
Program and Performance		7.4	8.4	9.1	12.9	22.1
Academic exchange programmes	USD million	320.1	357.8	372.8	369.8	372.1
	% of the total	54.9	56.7	56.8	56.1	55.2
Professional and cultural exchanges		214.7	221.5	223.6	225.6	227.1
Young leaders’ initiatives		28.5	31.3	34.4	34.4	35.0
Countering state disinformation and pressure		12.0	12.0	12.0	12.0	12.0
Community engagement exchange program		0	0	5.0	5.0	6.0
TOTAL		582.7	630.9	656.9	659.7	674.3

Source: calculated and constructed by the authors based on⁵⁰.

⁴⁹ *Bureau of Educational and Cultural Affairs*. URL: <https://www.state.gov/about-us-bureau-of-educational-and-cultural-affairs/> (accessed 27.10.2023).

⁵⁰ *2022 Comprehensive Annual Report on Public Diplomacy & International Broadcasting. Focus on FY 2021 Budget Data*. The United States Advisory Commission on Public Diplomacy (ACPD). 2022. p. 27. URL: https://www.state.gov/wp-content/uploads/2022/12/FINAL_2022_ACPD_AnnualReport_508Ready.pdf (accessed 27.10.2023).

Science and education diplomacy projects

It should be noted that public diplomacy often relies on rather light organisational forms, the management of which is entrusted to traditional authorities. We find sufficient evidence for this, as well as for the fact that the use of soft power is often based on non-linear relations in the system of subordination of actors' actions. The most common forms of science and education diplomacy include programmes and projects that often combine several dimensions, including science and education.

The cornerstone of the US Department of State's science diplomacy activities is a number of projects that have served as a kind of «locomotive» for the implementation of science diplomacy practices over the period of its operation. The most effective in terms of the number of foreigners involved in academic exchanges (more than half a million people) are the Fulbright Programme and the International Visitor Leadership Programme. Established in 1946, the Fulbright programme provides opportunities for Americans and citizens of more than 160 countries to study, teach and conduct research abroad. Its key components include, in particular, programmes for international students, foreign language teachers, visiting scholars and teachers, the H. H. Humphrey Scholarship Programme, specialised programmes, and many other programmes. According to the data presented in Table 4, the largest amounts of funding in the period 2017–2022 are allocated to the Fulbright East Asia Junior Teachers' Development Programme (USD 409.9 million, or 35.6 % of the total in 2022) and the Fulbright National Geography Scholarship (USD 200 million, 17.4 %). Next in terms of funding are the Fulbright Arctic Initiative (\$100 billion, 8.9 %), the Fulbright Amazonian Studies Programme (\$100 billion, 8.9 %), the Fulbright International Student Programme (\$87 million, 7.6 %), and the Fulbright Public Policy Scholarship (\$75 million, 6.5 %, respectively).

In addition to scientists and researchers, students and teachers as representatives of the academic community are also active participants in international exchanges that are dynamically integrated into the channels of science diplomacy. First of all, we are talking about *academic mobility*, which is currently being implemented on the institutional platform of transnational scientific infrastructure, double master's degrees, joint academic programmes, faculty exchanges, teacher internships, short-term study abroad, international training seminars for resolving various kinds of conflicts, etc. Suffice it to say, according to UNESCO, the global number of international mobile students in 1997–2021 increased from 1.9 to 6.4 million (Fig. 2), with an average annual growth rate of 5 % over the period.

Table 4

**AMOUNTS OF FUNDING
FOR THE FULBRIGHT PROGRAMME BY SPECIFIC AREAS,
USD million**

Fulbright programme area (year of foundation)	2017	2018	2019	2020	2021	2022
Fulbright programme, total	240	250	275	273	298	293.9
US Science Programme (1946)	31.0	30.0	33.0	32.8	35.8	36.0
Foreign Student Program (1946)	71.4	79.8	79.7	79.2	86.4	87.0
Visiting Scholar Program (1946)	22.0	22.5	24.7	24.6	26.8	26.0
Teacher Exchanges (1946)	10.6	11.8	11.6	11.6	11.6	10.6
U.S. Student Program (1946)	49.5	50.0	55.0	54.6	59.6	60.0
English Teaching Assistant Program (1949)	23.5	22.5	24.8	24.6	26.8	26.0
Foreign Language Teaching Assistant Program (1969)	6.1	5.4	4.0	4.0	5.4	5.4
Hubert H. Humphrey Fellowship Program (1978)	11.2	12.6	12.0	11.5	11.4	11.3
Specialist Program (2001)	3.3	4.7	4.6	4.6	4.5	4.5
Visiting Scholar Program for Iraq (2010)	1.1	1.1	1.1	0	0	0
Junior Faculty Development Program – Near East Asia (2012)	990.3	0	805.2	0	377.6	409.9
Public Policy Fellowship (2012)	0.705	0	0.461	0.430	0.075	0.075
National Geographic Storytelling Fellowship (2014)	160.4	200.0	127.9	143.6	155.3	200.0
Arctic Initiative (2014)	870.0	...	900.0	...	450.0	100.0
Amazonia Research Programme (2022)	100.0

Source: calculated and constructed by the authors based on⁵¹.

⁵¹ 2022 *Comprehensive Annual Report on Public Diplomacy & International Broadcasting. Focus on FY 2021 Budget Data*. The United States Advisory Commission on Public Diplomacy (ACPD). 2022. p. 27. URL: https://www.state.gov/wp-content/uploads/2022/12/FINAL_2022_ACPD_AnnualReport_508Ready.pdf (accessed 27.10.2023). pp. 32–36.

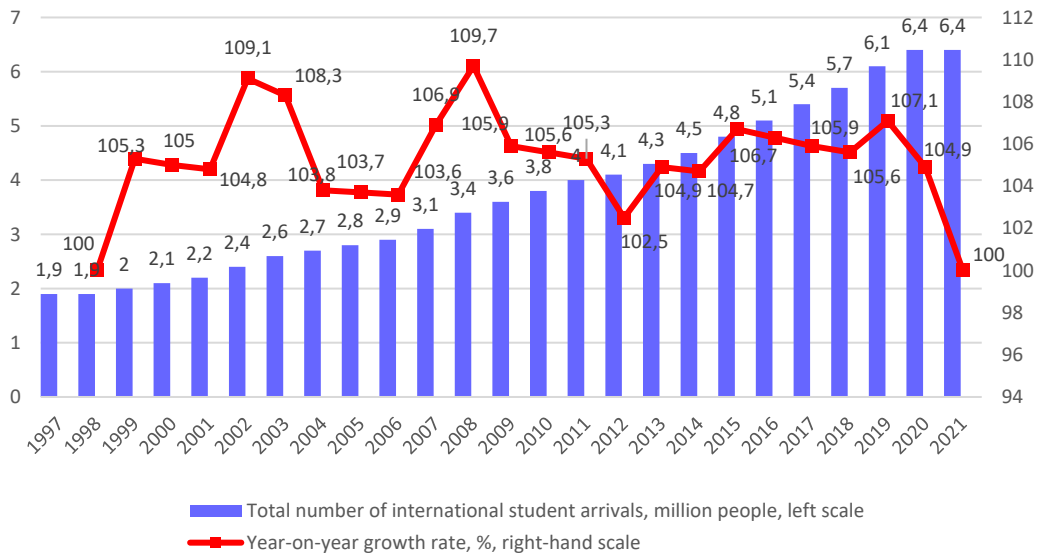


Figure 2. Dynamics of international student arrivals in 1997–2021

Source: calculated by the authors based on⁵².

While during the Cold War, student exchanges were rather limited and largely implemented for ideological and propaganda reasons⁵³, today this phenomenon has, without exaggeration, become global in scope, involving almost all countries of the world, all student contingents and all possible organisational formats of academic mobility. It should be emphasised that various formats and institutional platforms of academic mobility allow its participants not only to fully understand the economy, culture and peculiarities of the social and humanitarian environment of the host countries, but also to establish useful contacts for future professional activities and to join global professional networks. For example, in the United States of America, more than 914,000 foreign students studied in the post-pandemic period (2020–2021), which not only brought in \$28.4 billion in revenue to the state budget but also supported about 106,000 students and supported about 306.3 thousand jobs, but also made a significant

⁵² Inbound internationally mobile students by continent of origin. UNESCO. URL: <http://data.uis.unesco.org/#> (accessed 25.10.2023).

⁵³ This refers primarily to the education of students in the former USSR, mostly from the socialist camp and developing countries that were within its economic, political, military and ideological sphere of influence (author's note).

contribution to US scientific and technological research and the development of local communities, brought new creative ideas to the educational process, and helped prepare their American peers for global careers⁵⁴.

Emergent science and education diplomacy

Another indicator that can be used to judge the scale of the academic exchange channel of science diplomacy mechanisms implemented by states today is the *annual revenue of the global online education market*. According to the data for 2017–2023 alone, it increased from 65.6 to 166.6 billion US dollars. According to expert estimates, it will reach USD 329.3 billion by 2027 (Fig. 3), with an annual growth rate of 9.5 % in 2023–2027.

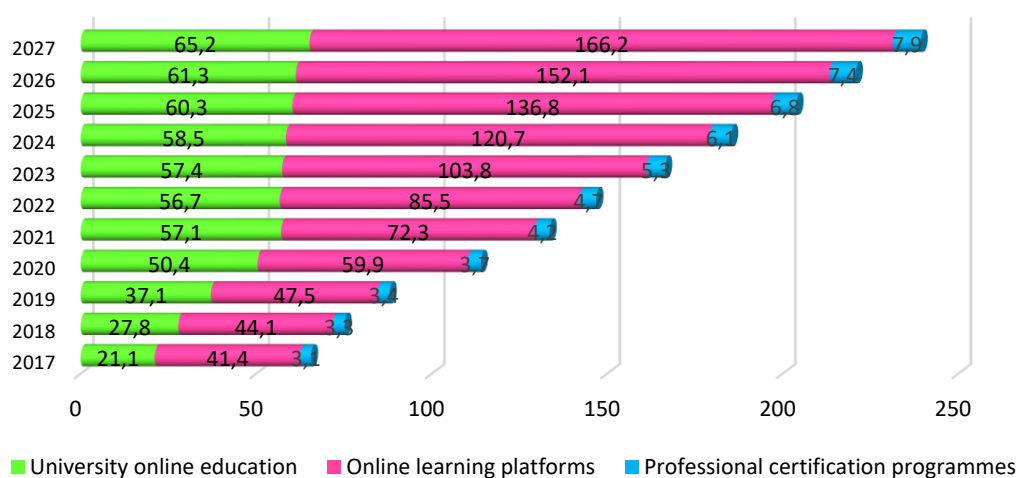


Fig. 3. Dynamics of annual revenues of the global online education market, USD billion

Source: compiled by the authors based on data from⁵⁵.

At the same time, the largest increase in revenues is currently observed in the segment of online university education, whose annual revenues increased from USD 41.4 billion in 2017 to USD 103.4 billion in 2023 (166.2 billion

⁵⁴ 2022 *Comprehensive Annual Report on Public Diplomacy & International Broadcasting. Focus on FY 2021 Budget Data*. The United States Advisory Commission on Public Diplomacy (ACPD). 2022. pp. 8. URL: https://www.state.gov/wp-content/uploads/2022/12/FINAL_2022_ACPD_AnnualReport_508Ready.pdf (accessed 27.10.2023).

⁵⁵ Ibid.

in 2027), followed by online learning platforms (from 21.1 to 57.4 billion, 65.2 billion in 2027) and professional certification programmes (from 3.1 to 4.2 billion, 7.9 billion USD respectively)⁵⁶. Similar dynamics are also characteristic of the quantitative parameters of the subjects covered by all formats of online education: if in 2017 their global number was 307.1 million people, in 2023 it will be 807.5 million, and in 2027 it will reach more than 1 billion people.

At the same time, *world-class universities* are the central academic link in the implementation of science diplomacy programmes and projects by states, organically integrating educational and scientific functions in their activities, playing a leading role in global processes of production, commercialisation and large-scale cross-border transfer of knowledge and technology. As the central link in the training of highly qualified professionals and researchers, as well as in conducting innovative research and development in the most pioneering areas of global scientific and technological progress, universities have in recent decades become unique discussion platforms for interaction between scientists, politicians, representatives of the business community, the media and civil society. In addition, universities play a role in ensuring the functioning of social lifts and inter-sectoral career mobility. For example, in 2012, Stanford University Professor M. McFaul became the United States Ambassador to the Russian Federation, and in 2017, the Chairman of the Atlantic Council, diplomat J. Huntsman was appointed to this position. On the other hand, former US Congressman L. Hamilton headed the Woodrow Wilson Center, and many high-ranking US officials are currently working as experts at the Brookings Institution, including, incidentally, former US Ambassador to Ukraine S. Pfeiffer.

All of the above features of universities give grounds to qualify them as powerful institutional platforms for states to implement a wide range of scientific and diplomatic functions through large-scale transmission of new creative ideas to the world community. This is done through speeches of political and opinion leaders to students, involvement of students in research work of universities and conducting classes by world-renowned scientists, establishment of various think tanks and research associations within the organisational structure of universities, holding theoretical and practical conferences and interaction with the media, etc. Thus, academic think tanks, having quite diversified sources of funding (grants, sponsorship from individuals, organisations and charitable foundations, etc.), in most cases take a neutral and unbiased position in conducting long-term research, generating new innovative ideas, expanding the horizon of planning political activities of their countries and providing them with comprehensive scientific

⁵⁶ Online Education – Worldwide. *Statista. The Statistical Portal*. URL: <https://www.statista.com/outlook/dmo/eservices/online-education/worldwide> (accessed 13.10.2023).

and consulting support in developing international cooperation and solving the most pressing socio-economic and political problems.

At the same time, the rapid processes of internationalisation experienced by academic institutions in recent decades have significantly increased the organisational, economic and institutional resources for their participation in the implementation of scientific and diplomatic activities through the implementation of joint academic programmes and the development of transnational research and education infrastructure. The network self-organisation inherent in academic science significantly enhances the competitive position of university institutions in institutional networks of scientific and diplomatic activities. For example, the main staff of the National Brookings Institution, which belongs to the group of independent academic institutions and national institutes of advanced studies in the United States, are people from the government and politics, namely former politicians, government officials, diplomats and US congressmen. As a result, this institution, organically combining academic and public strategies, is now deeply embedded in the institutional «backbone» of American science diplomacy. It offers politicians a broad view of domestic and international issues, develops effective mechanisms for implementing the foreign policy of the presidential administration and solving complex international problems, and provides the US political establishment with powerful intellectual support in making key management decisions, similar to what consulting companies and agencies do when selling their expertise⁵⁷.

The next current trend in the development of science diplomacy, which has gained a particularly high rate of development in recent decades, is the *rapid intensification of publication activities of international teams of authors and the increase in the maximum number of authors per international publication*. This is due, on the one hand, to the growing complexity and sophistication of scientific research and the need to recognise and take into account the contribution of everyone, and, on the other hand, to the availability of technical and organisational capabilities to conduct complex research. Moreover, such research requires both adequate funding and international co-operation of co-authors.

It is worth noting that, while remaining a rather rare phenomenon back in the 1970s and 1980s, international publication collaborations have been developing particularly rapidly since the 2000s, when more than half of the scientific articles in each country have a foreign co-author⁵⁸. While at the beginning of the twentieth century, no more than 10 % of the total number of scientific papers were published in international co-authorship, today it is

⁵⁷ Drezner D. W. *The Ideas Industry: How Pessimists, Partisans, and Plutocrats are Transforming the Marketplace of Ideas*. New York, Oxford University Press, 2017. 360 p.

⁵⁸ Adams J. The Fourth Age of Research. *Nature*. 2013. Vol. 497. P. 557–560.

about 50 %⁵⁹. For example, the share of publications with international co-authors by Harvard University professors increased from 22.1 to 46.7 % of the total number of published scientific papers in 2001–2021, while the average for all American universities increased from 17 to 36.6 %, respectively⁶⁰. At the same time, although the international publication activity of scientists provides a significant increase in the level of citation of their scientific articles, its intensity directly depends on the field of scientific knowledge⁶¹. As for the maximum number of authors per international publication, according to the Clarivate report «Mega-authorship and scientific analytics», until 2000, the maximum number of co-authors per scientific publication did not exceed 500 people, while in 2004 this figure increased to 2.5 thousand, in 2015 – to almost 5.2 thousand⁶², and in 2021 – more than 15 thousand scientists. The latter represented the CovidSurg research group from 122 countries, which worked on the issue of vaccinating patients before surgery and included in the article summarised clinical results of 140 thousand patients⁶³.

It should be emphasised that the United States has been a leader in the world in recent decades in terms of many bibliometric indicators of scientific activity. In particular, according to the global ranking of scientific institutions of the *Scimago Journal Ranking* analytical platform, which summarises and makes publicly available the ratings of their publication activity and statistics on citations of publications in the *Scopus* scientometric database, in the period 1996–2022, the top ten countries included the United States, China, the United Kingdom, Germany, Japan, France, India, Italy, Canada and Australia (Table 5). At the same time, the United States is leading by a large margin from the rest of the countries in this ranking, which indicates its superior competitive advantages not only in terms of the number of publications in the *Scopus* database, but also in terms of the effectiveness of research and development, the level of development of international scientific and technical cooperation, and the value of the normalised impact factor. However, European countries collectively have more than 30 % of the citations and 25 % of the cited documents.

⁵⁹ Wagner-Doebler R. Continuity and Discontinuity of Collaboration Behaviour Since 1800 from a Bibliometric Point of View. *Scientometrics*. 2001. Vol. 52. No. 3. pp. 505.

⁶⁰ *Publications with International Co-Authors*. URL: <https://oneworld.worldwide.harvard.edu/publications-with-international-co-authors/> (accessed 27.10.2023).

⁶¹ Knobel M., Simões T. P., De Brito Crus C. H. International Collaborations Between Research Universities: Experiences and Best Practices. *Studies in Higher Education*. 2013. Vol. 38. No. 3. P. 405–424.

⁶² Adams J., Pendlebury D., Potter R., Szomszor M. *Global Research Report Multi-authorship and research analytics*. Institute for Scientific Information. 2022. URL: https://clarivate.com/wp-content/uploads/dlm_uploads/2022/09/ISI_Global_Research_Report_6_v9_RGB_SP.pdf (accessed 27.10.2023).

⁶³ *Global COVID-19 surgery study scoops scientific world record*. University of Birmingham. URL: <https://www.birmingham.ac.uk/news/2021/global-covid-19-surgery-study-scoops-scientific-world-record> (accessed 27.10.2023).

Table 5

TOP 20 COUNTRIES IN THE SCIMAGO JOURNAL RANKING IN 1996-2022

Place in the ranking	Country	Number of publications in Scopus	Number of cited documents	Number of citations	Number of self-citations	Number of citations per publication	Hirsch index
1	USA	20,5 %	19,5 %	28,1 %	41,7 %	30,78	2880
2	China	12,4 %	13,3 %	7,1 %	14,8 %	12,88	1210
3	United Kingdom	6,1 %	5,5 %	7,7 %	5,7 %	28,43	1815
4	Germany	5,2 %	5,2 %	6,0 %	4,7 %	25,59	1584
5	Japan	4,5 %	4,7 %	3,9 %	3,3 %	19,33	1236
6	France	3,6 %	3,6 %	4,1 %	2,7 %	25,5	1420
7	India	3,6 %	3,6 %	1,9 %	2,3 %	11,97	795
8	Italy	3,2 %	3,1 %	3,3 %	2,6 %	23,32	1255
9	Canada	3,1 %	3,0 %	4,0 %	2,2 %	29,00	1460
10	Australia	2,5 %	2,4 %	3,0 %	2,0 %	26,66	1276
11	Spain	2,5 %	2,5 %	2,5 %	1,8 %	22,27	1127
12	RF	2,1 %	2,3 %	0,8 %	1,0 %	8,62	702
13	Republic of Korea	2,0 %	2,1 %	1,6 %	1,0 %	17,92	863
14	Brazil	1,8 %	1,8 %	1,2 %	1,3 %	14,69	729
15	Netherlands	1,7 %	1,7 %	2,6 %	1,2 %	34,04	1284
16	Switzerland	1,3 %	1,3 %	2,0 %	0,8 %	34,77	1212
17	Poland	1,2 %	1,3 %	0,7 %	0,6 %	13,52	687
18	Sweden	1,2 %	1,2 %	1,6 %	0,7 %	31,6	1087
19	Turkey	1,1 %	1,1 %	0,7 %	0,5 %	13,45	562
20	Taiwan	1,1 %	1,2 %	0,9 %	0,5 %	17,8	648
	TOTAL	74 231 087	68 161 601	1 664 557 464	468 961 820	-	-

Source: compiled by the authors based on data from⁶⁴.

⁶⁴ Scimago Journal & Country Rank. URL: <https://www.scimagojr.com/countryrank.php> (accessed 22.10.2023).

Science diplomacy platforms

In a comprehensive analysis of the mechanisms for the implementation of science diplomacy by states, we cannot ignore the *platforming of professional cooperation between scientific attaches of different states*. In many areas of activity, the platforms⁶⁵ have proven to be effective as an organisational form of establishing interaction between autonomous actors seeking opportunities to achieve common goals.

Our study focuses primarily on the activities of such platforms as *Science & Technology Diplomatic Circles (S&TDC)*, which bring together scientific attachés of diplomatic institutions of foreign countries located in different countries on their institutional platform. They make it possible to significantly deepen the interaction between multi-level participants in national innovation ecosystems through the organisation of cross-border technology transfer and the implementation of diversified formats of international scientific, technical and innovation collaborations, consortia, cross-border and international clusters.

This kind of science diplomacy format is most widespread in the so-called global cities (such as Barcelona⁶⁶, Singapore⁶⁷, Boston⁶⁸, Tokyo⁶⁹, Shanghai⁷⁰, etc.), which, according to C. Sassen⁷¹, are not only global points of accumulation of human, financial, investment and information capital, but also local platforms for establishing a wide range of official, business and scientific contacts of different national actors. It is here that the lion's share of international business tourism flows is directed and the global production of highly specialised professional services of financial institutions, consulting and audit companies, lawyers' associations and advertising agencies is concentrated.

It is only natural that Diplomatic Circles on Science and Technology, located in global cities, have become an integral structural component of the international activities of research and innovation centres in many countries in recent years. For example, the Singapore-based Diplomatic Circle currently unites members of more than forty diplomatic missions and international organisations based in Singapore and offers an institutional platform for cooperation between officials and career diplomats from different countries, as well as representatives of national governments,

⁶⁵ Kenney, M., & Zysman, J. (2016). The rise of the platform economy. *Issues in science and technology*, 32(3),61.

⁶⁶ Barcelona Science and Technology Diplomatic Circle. URL: <http://www.scitechdiplohub.org/diplomatic-circle>.

⁶⁷ Science & Technology Diplomatic Circle Singapore. URL: <https://www.stdc-singapore.org>.

⁶⁸ Science and Technology Diplomatic Circle of Boston. URL: <http://stdc-boston.com/>.

⁶⁹ Science & Technology Office Tokyo. URL: <https://www.stofficetokyo.ch/about-us>

⁷⁰ Science & Technology Diplomatic Circle Shanghai. URL: <https://www.stdc-shanghai.org/>

⁷¹ Sassen S. *The Global City: New York, London, Tokyo*. Princeton University Press, 1991. 397 p.

scientific elites, the political establishment and the corporate sector in the field of science, education, innovation and technology⁷². Thanks to this cooperation, the member states of the Singapore diplomatic circle have unlimited opportunities to implement a wide range of science diplomacy tools based on the development of sustainable cooperative ties between all its participants and integration into the global innovation ecosystem.

Another case worthy of attention is the Boston Diplomatic Circle. The main goal of the Boston Diplomatic Circle’s regional platform for science and technology is to build the innovation ecosystem of Massachusetts (USA) through comprehensive support of informal scientific exchanges between consulates and diplomatic missions of many countries (Canada, Colombia, Germany, Italy, the Netherlands, Mexico, Switzerland, etc.) located here, on the one hand, and officials, academics and private business representatives of the state, on the other. Thus, in order to support newly appointed employees of foreign diplomatic missions located in Boston⁷³ in their entry into urban and national innovation ecosystems, a Master of Arts in Law and Diplomacy (MALD) project was completed in 2020 on the basis of the S&TDC platform. It was implemented at the Fletcher School of Law and Diplomacy at Tufts University (with the participation of diplomatic missions from 65 countries), during which a number of virtual briefing sessions were held for academic diplomats and a wide range of services and information resources available to them were presented to build close collaborative ties with representatives of innovation ecosystems⁷⁴.

Ukraine, as a country affected by military aggression from its northern neighbour, has begun to use the potential of platforms to preserve and develop its scientific potential. First and foremost, the Ukrainian Scientific Diaspora platform⁷⁵ was launched in 2022 as an initiative⁷⁶ of enthusiasts from the Massachusetts Institute of Technology and the Office of Scientist Support of the Young Scientists Council at the Ministry of Education and Science of Ukraine. Despite the fact that over the past 30 years, Ukraine has lost a significant portion of its scientific personnel due to their emigration, no steps have been taken to use their potential for the country’s economic development until 2022. The platform and initiative to connect the Ukrainian scientific diaspora is the first attempt to improve the efficiency of managing the potential of domestic intellectual capital currently located abroad.

⁷² Science & Technology Diplomatic Circle Singapore. URL: <https://www.stdc-singapore.org>.

⁷³ Note. A significant number of diplomatic missions of foreign countries are currently concentrated in Boston.

⁷⁴ Gota K., Lichte L., Berkman P. A. *Science Diplomacy Case Study: The Boston Innovation Ecosystem and its Science & Technology Diplomatic Circle*. URL: https://www.researchgate.net/publication/345459614_Science_Diplomacy_Case_Study_The_Boston_Innovation_Ecosystem_and_its_Science_Technology_Diplomatic_Circle_STDC (accessed 26.10.2023).

⁷⁵ Note. See <https://ukrdiaspora.nauka.gov.ua/>

⁷⁶ Polishchuk Y., Lyman I. Chugaievska S. The «Ukrainian Science Diaspora» initiative in the wartime. *Problems and Perspectives in Management*. 2023. 21(2-si), pp. 153–161. doi:10.21511/ppm.21(2-si).2023.18

Although it is too early to draw any conclusions, the very fact of such an initiative is a step towards catching up with more developed countries that actively use the potential of science diplomacy.

Technology ambassadors and scientific and diplomatic networks

Another newest institutional format of science diplomacy is represented today by the *institution of technology ambassadors*, which involves states sending their ambassadors not to specific foreign countries, but to their technology sectors and companies. For example, a few years ago, the Office of the Danish Technology Ambassador was established and since 2017, this country has been implementing *the TechPlomacy* initiative, which was first enshrined in the Danish Foreign and Security Policy Strategy for 2017–2018. It is worth noting that the current mandate of this initiative, in addition to the state policy in the field of foreign relations and security, also covers a diversified scientific and diplomatic toolkit for implementing political practices in the cyber sector, foreign trade and investment, as well as a number of Danish sectoral policies at the bilateral and multilateral (pan-European and integration) levels.

It is important to note that in today's environment of significant intensification of international competition between multinational economic actors for scientific, technological and innovative resources of civilisational development, each state is characterised by its own model of implementing its own scientific and diplomatic practices. In their staffing, most countries rely on specially engaged experts who work side by side with career diplomats from among local staff of foreign embassies, seconded diplomats and officers from their countries. Meanwhile, in recent years, states have been increasingly crystallising the trend of *dynamically expanding their own scientific and diplomatic networks*⁷⁷ and *establishing foreign innovation centres closely linked not to embassies and consulates, but to global innovation clusters*. As an example, let us cite *Swissnex*, a global network of education, research and innovation in Switzerland, which includes innovation centres in the United States, China, India and Brazil. It is supported by a large team of initiators in addition to scientific and technical departments and twenty consultants in Swiss embassies in major cities around the world⁷⁸.

Another eloquent example is the *UK Science and Innovation Network (SIN)*, founded in 2001, which currently employs about 130 people in 65 countries in four world regions – Europe, Asia-Pacific, India, the Middle

⁷⁷ Comment. Closely linked to their embassies abroad.

⁷⁸ *Swissnex*. URL: <https://swissnex.org/about-us> (accessed 26.10.2023).

East and Africa, and the Americas⁷⁹. The main functions of this institution are to build extensive partnerships and collaborations in the field of science, technology and innovation in different parts of the world through SIN's cooperation with local scientific and innovation organisations, comprehensive support for the UK's science and technology policy abroad and the realisation of its national interests in the global innovation race. Among the most successful projects implemented by the UK Science and Innovation Network in the field of science diplomacy are the European Offshore Wind and Marine Energy Research Programme (jointly with France); the Climate Change Mitigation and Health Research Programme (jointly with Italy); the International Programme on Marine Protected Areas, Biodiversity and Climate Change (jointly with Chile), etc.

In addition, everyone is also witnessing the emergence *and dynamic development of such convergent scientific and diplomatic formats as national diaspora networks of research and academic institutions and civil society organisations*. According to international experience, they are able to have a direct impact on the development and implementation by national governments of innovative strategies and best scientific and diplomatic practices through the use of public-private partnership mechanisms, promotion of global entrepreneurship and bringing together representatives of the scientific, technological and engineering diaspora, the private sector and government institutions on one institutional platform⁸⁰.

The vast majority of such networks receive significant support from the national governments of the countries of origin of diaspora representatives in the form of resource mobilisation, coordination of cooperation between all stakeholder groups, and creation of favourable conditions for research and innovation. As an example, let's look at the Spanish Science Diplomacy Strategy, which is currently being developed from the bottom up and involves a large number of stakeholders. As of today, there are at least thirty associations of Spanish researchers abroad, united on the institutional platform of the Spanish Ministry of Foreign Affairs. For example, Espacoles Científicos en USA, the largest network of Spanish scholars in the United States, currently has more than 850 members from thirty states and has regional chapters in Washington, Boston, New York, California and the Midwest⁸¹. This diaspora network promotes Spain's implementation of a wide range of scientific and diplomatic practices through the exchange of scientific

⁷⁹ *UK Science and Innovation Network*. URL: <https://www.gov.uk/world/organisations/uk-science-and-innovation-network> (accessed 26.10.2023).

⁸⁰ *Cooperation with the scientific diaspora as a resource for the development of science and innovation*. Analytical note. National Institute for Strategic Studies. Centre for Social Studies. 2021. c. 4. URL: <https://miss.gov.ua/sites/default/files/2021-05/naukova-diaspora.pdf> (accessed 27.10.2023).

⁸¹ Moreno A. E., et al. *Spanish Science Diplomacy: A Global and Collaborative BottomUp Approach*. *Science & Diplomacy*. 2017. Vol. 6. No. 1. URL: <http://www.sciencediplomacy.org/article/2017/spanish-science-diplomacy-global-andcollaborative-bottom-approach> (accessed 26.10.2023).

ideas and the organisation of seminars, close cooperation with the American Academy for the Advancement of Science, and the involvement of Spanish scientists in the implementation of various pilot research projects in the United States in the areas of human brain research, nanotechnology, biodiversity conservation, renewable energy, social institutions, global asymmetries of socio-economic development, etc.

Climate diplomacy

In the scientific discourse, climate change⁸² has long been a subject of research, but in the practical sphere, diplomatic efforts in this context are often within the competence of either diplomats or scientists. At the same time, it should be acknowledged that scientific discussions often form the basis for subsequent political decisions and agreements, so Ukraine's proper representation in this area should be ensured based on the expediency of combining the efforts of scientists and diplomats.

Despite the fact that the Scopus database currently contains only about 130 papers with the keywords «climate diplomacy» and the authors of these papers represent mainly developed countries, India and China, we believe that this area will experience significant growth in the coming years. This is due both to the fact that the largest number of publications occurred in the last two years and to the growing intensity of efforts to implement the Sustainable Development Goals, which are largely related to the management of anthropogenic impact on the environment.

Conclusions

Summarising the above, we can state that science diplomacy, by its substantive nature and implementation mechanisms, represents a deep convergence of two crucial areas of human activity – science and diplomacy, and therefore is based on close cooperation between scientists, diplomats and representatives of business communities in applying fundamental knowledge and research and development results in the implementation of various economic and political goals by states in global coordinates. It envisages continuous and multifaceted interaction between science, government and business across all structural links of the process of expanded reproduction of innovative products in order to implement national foreign economic policies, maximise their economic benefits and minimise losses in the international arena. Although it cannot effectively resolve the entire complex of deep-rooted interstate contradictions and conflicts, it opens up wide opportunities for strengthening interstate and inter-civilisational dialogue in

⁸² Ilnytskyy, D., & Stoliarchuk, J. «Greening» of energy and the new quality of globalisation. *International Economic Policy*. 2023. No. 1(38). C. 7–39

the context of growing global political and economic turbulence, intensification of disintegration processes, and synchronisation of crisis phenomena in the world economic system.

The intensification of activities aimed at using the economic potential of science has led first to its internationalisation, and then to the use of various institutional forms of international academic entrepreneurship and competitive interaction, which involve actors who have traditionally focused their activities on the domestic research and education space. Despite the emergence of many new forms of public diplomacy (innovation diplomacy, climate diplomacy, etc.) and tools for their implementation (platforms, networks, technology ambassadors and joint publications, etc.), it remains auxiliary to traditional diplomacy and the realisation of national interests.

Based on the conducted research, domestic authorities should effectively use the potential of public diplomacy. First of all, it is advisable to develop an applied methodology for accounting and evaluating the effectiveness of known types of public diplomacy. Further research is needed on the newest forms of public diplomacy, the recognition of which will be a sign of a broader understanding of the ways to realise national interests in the global economy, which is currently undergoing transformation. Almost all global problems of humanity with an economic dimension will require special approaches to solving them and the identification of appropriate types of public diplomacy, which should be based on further research.

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