# Enhancing EaP-EU cooperation in R&I through comparative analyses of EaP national research systems

## Re-granting project 2020

Working Group 4

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**About the Eastern Partnership Civil Society Forum**
EaP CSF[1] is the largest umbrella organisation of NGOs from the Eastern Partnership region and the EU, working together with 1000+ organisations to promote European integration, facilitate reforms and democratic transformations in the six Eastern Partnership countries – Armenia, Azerbaijan, Belarus, Georgia, Moldova and Ukraine.



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Unites about 60 professors and researchers interested in European studies. Monitors the ongoing processes in the sphere of research and innovative activities in Georgia by scientometric, sociological, comparative-analytical and other accessible methods; studies the research and innovation policy directions/trends of the European Union and other individual countries and work out recommendations for their introduction in Georgia; elaborates and implements the forms of communication (lectures, seminars, conferences, scientific articles, electronic and printed media publications) with different groups of society (academic circles, students, general

[1] Eastern Partnership Civil Society Forum (https://eap-csf.eu/)

public, government, political parties); cooperates with interested Georgian and foreign scientists, also with research, educational, governmental and non-governmental organizations

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**Knowledge Hub Moldova NGO, Moldova**
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**Sergiu Porcescu (Researcher).** PhD degree in political sciences. Has over 10 years' experience in the area of R&D policies. He served as: the head of European Integration and International Cooperation Department of the Academy of Sciences of Moldova; director of the Moldovan Office for Science and Technology in Brussels; National Coordinator of the Network of National Contact Points for EU FP7 and Horizon 2020 Program; National Contact Point of EC Joint Research Center for Moldova. He was also the Moldova delegate to European Research Area Council's Strategic Forum for International Cooperation (SFIC) and High-level Group for Joint Programming (GPC), Eastern Partnership Panel on Research & Innovation and Eastern Partnership Platform 4 'Contacts between people'. Currently, he is a member of the task force dealing with the implementation of the smart specialization concept of Moldova and also a national expert for UNECE.

**Karen Chilingaryan (Researcher)** Chairman of the Consumers' Consulting Center NGO. The organization was founded in 2013 and is engaged in protecting consumer rights and consulting. He has participated in the Conferences, WG 2 meetings and Annual Assemblyes of the Eastern Partnership Civil Society Forum implemented in 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019 and from 2011 to 2019 he has been the Coordinator of the 2nd working group of Eastern Partnership Civil Society Forum Armenian National Platform. Regular participation at the EAP CSF Armenian National Platform's meetings. He has considerable experience in working with governmental agencies for collecting statistic and other information.

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**Content**

**Abbreviations**

| | |
|---|---|
| AA | Association Agreement |
| CS | Civil Society |
| CSF | Civil Society Forum |
| DCFTA | Deep and Comprehensive Free Trade Agreement |
| DG EAC | Department-General for Education, Youth, Sport and Culture |
| DG NEAR | Department-General for Neighborhood and Enlargement Negotiations |
| DG R&I | Department-General for Research and Innovation |
| EaP | Eastern Partnership |
| EC | European Commission |
| EEAS | European External Action Service |
| ERA | European Research Area |
| EU | European Union |
| GERD | General Expenditure on Research and Developmwnt |
| H2020 | The EU research and innovation programme Horizon 2020 |
| HEI | Higher Education Institutions |
| HQR | Highly Qualified Researcher |
| JRC | Department-General Joint Research Center |
| NAS | National Academy of Sciences |
| NP | Eastern Partnership Civil Societies Forums' National platform |
| OECD | Organization for Economic Cooperation and Development |
| PhD | Philosophy doctor |
| PISA | The Programme for International Student Assessment |
| PSF | Policy Support Facility |
| R&D | Research and development |
| RDI | Research, development and innovation |
| SGUA | The Support Group for Ukraine |
| STI | Science, technology and innovation |

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## THE PROJECT EXECUTIVE SUMMARY

**The project has 4 specific objectives:**

- Contribute to advancing reforms in EaP countries in one of the areas covered by EaP CSF Working Groups, namely EaP Platform and Panel on R&I.
- Ensure full-fledged participation of civil society organisations in the process of implementation of the EaP via institutionalizing and strengthening mechanisms of dialogues between the EU and civil society, between the national governments and the EaP civil society, and between the EU, national governments and EaP civil society in R&I sphere creating new information base for further dialog.

- Strengthen the regional perspective by covering R&I state in all 6 EaP countries with an explicit focus on bridging the emerging gaps in R&I area among the EaP countries, and the EU.
- Strengthen the role of EaP CSF in EaP policy development and contribute to effective advocacy of EaP CSF developing an effective research-based tool deserving serious consideration by EaP R&I policy stakeholders.

**The project target groups are:**

- The EU institutions and agencies: DG R&I; DG NEAR; DG EAC; EEAS; JRC.
  *To understand better EaP countries' research systems and their development trends; to see better their efforts and output in processes; to formulate next stage of EaP policy on R&I*.
- EaP countries governments, parliaments, ministries, agencies, academies of sciences, universities, and research entities.
  *To see in details comparative achievements of their countries, reveal shortcomings and develop country policies, as well as formulate informed demand to the EU agencies.*
- Participants of the EU assistance projects in R&I sphere.
  *To see additional angles of EaP countries' R&I systems not covered by the past and ongoing projects.*
- Academics and industrialists
  *To formulate informed demand on their governments in R&I sphere.*
- Civil society (EaP CSF, EaP CSF NPs; general public)
  *To obtain a useful tool for better monitoring and assessment of governments' and the EC agencies' activities in EaP Initiative.*

In the course of the project implementation the project team found strong reasons to focus on the factor of impact of national R&I systems on education in the country as the main factor of country's long-term well-being. The system-forming element that determines the highest possible quality of education in the country is today the forming of highly qualified teaching personnel for the educational sphere (for HEI in the first place), which is provided by the national R&D system. The present report, on the basis of non-conventional indicators, evaluates the quality of PhDs training in each of EaP countries. Another critical area, detailed in the report, is the legal environment regulating research activities in EaP countries. In the report, the main normative documents regulating R&D activities in each of the countries are compared among themselves, as well as with their analogs in selected European countries using a sort of content analysis. One more problem studied and presented in the report is migration of researchers, formation of scientific diasporas and 'brain drain' in EaP countries compared with selected post-socialist EU members. Based on the analysis of the data obtained, conclusions related to the region as a whole are drawn and recommendations for improving policies of the EU and partner countries in relation to national R&D systems are presented.

## Key Policy Messages

**Message 1**
Research and education systems in EaP countries are lagging far behind those of the EU countries. Taking into account the fact that education belongs to the category of fundamental human rights, as well as the fact that the modern education system cannot exist without a research system, raise the attention to development of R&D and education systems within the framework of the EaP Initiative to the level of attention to problems of human rights, democracy and justice.

**Message 2**
To devote a special summit (EaP Summit) to development of the human capital in EaP countries, where it will be recognized that the current state of R&D and education systems pose a threat to the successful development and stability of EaP countries.

**Message 3**
To take a decision at the EaP summit to revise plans and roadmaps in the field of R&D and education arising from Association Agreements with associated countries, as well as from agreements with non-associated countries participating in the EaP Initiative.

**Message 4**
To take a decision at the EaP summit on the real application of the 'more for more' principle in the spheres of R&D and education.

**Message 5**
Strengthen, following the example of the areas of human rights, democracy and justice, monitoring of the state of affairs and the implementation of recommendations in the field of R&D and education, using the EaP Civil Society Forum platform.

**Message 6**
Strengthen, following the example of the areas of human rights, democracy and justice, advice to the governments of the EaP countries in the field of national R&D policy and the management of R&D systems by organizing a 3-year project coordinated by European organizations. It can be a project within Horizon Europe, or a project like *The Support Group for Ukraine (SGUA)* (https://ec.europa.eu/neighborhood-enlargement/neighbourhood/countries/ukraine/sgua_en).

**Message 7**

In the framework of monitoring (Chapter 4, Recommendation 4) and consulting/advising (Chapter 4, Recommendation 5) projects, explore and resolve a number of research and technical issues:

- Study the reasons for the concentration of Highly Qualified Researchers (HQR) from EaP countries in the USA, not in the EU.
- Develop for EaP countries a policy framework for engaging with scientific diasporas, defining in it also the possible role of the EU.
- To encourage EaP research institutions and HEIs to adopt and implement The European Charter & Code for Researchers (https://euraxess.ec.europa.eu/euraxess/charter-code-researchers).
- Formulate recommendations on the clear formal requirements for persons appointed / elected to leadership positions in R&D and higher education, as well as for appointment / election procedures.
- To introduce continuous training for researchers, to organize science management training for managers.
- Develop recommendations for the reform of the process of PhD studies, with a view to increasing the requirement for admission to post-graduate study, and considering post-graduate students as capable, motivated researchers willing to work for a modest salary, but not as a source of income for the organizations in which they work, as well as revising the timing of post-graduate study.

## Introduction

Everyone has the right to education
*Universal Declaration of human rights*

This report presents the EaP CSF's view of R&D development processes in the EaP countries, formed as a result of research carried out by a group of scientists - CS representatives - within the framework of a project supported by the EaP CSF Secretariat. Financial support was provided by the EC and the National Endowment for Democracy (USA).

The convergence of the national R&D systems of the EaP countries with the EU research system (European Research Area – ERA, 2000) is provided for by the policy of the Eastern Partnership Initiative (2008). It is seen as one of the directions of European integration of EaP countries. Research, Development and Innovation (RDI) activities are included in the Deliverables 2020 (EaP, 2017) of the EaP Initiative. Particular attention is paid to integration into the ERA in the annual Action Plans of Moldova, Georgia and Ukraine, which have signed Association Agreements (2014) with the EU. In this regard, the EC at the request of the governments of the partner countries in 2018-2019 carried out an assessment of the R&D and RDI systems in Armenia, Georgia, Moldova and Ukraine using a special tool called the Policy Support Facility (PSF) (https://rio.jrc.ec.europa.eu/policy-support-facility). The PSF missions' reports for these countries were the starting point for our study. The main feature (distinguishing feature) of our work is that

we study the EaP region as a whole, i.e. we compare conventional and non-conventional indicators of the state of national R&D systems and identify trends that characterize the region as a whole.

The aim of the work is to form the basis for the EU policy towards the region as a whole, as well as to formulate conclusions on which each of the EaP countries should base on their own development and European integration policies in the field of R&D.

An extract from the Universal Declaration of Human Rights (1948) is quoted at the beginning of the report because, studying the issue, the project team focused on the factor of the impact of national R&D systems on education in the country as the main factor of country's long-term well-being. The reason of focusing on education function of research system is also a low level of the quality indicators for education systems in EaP countries compared to EU member post-socialist countries. The OECD PISA (2018) indicators' values for science performance of students place Estonia the 5th best among all countries, Poland – 9th, Latvia – 26th, and Lithuania -30th. While Belarus – 34th, Ukraine – 35th, Moldova – 49th, Azerbaijan – 66th, and Georgia – 71st[2].

The impact of R&D systems on other factors of development, such as innovation, public administration, formation of the intellectual elite, etc., are considered in less detail, due to the limited time and financial framework of the project from the one side, and low probability of economic impact of EaP R&D systems in their current condition, from another. The probability of economic impact by a national R&D system grows with the GERD growth and becomes considerable when GERD is above 0.9-1% (Malyckyj BA, 2007, p. 179). The lower GERD, as in the case of EaP R&D systems, gives only socio-cultural effects.

The value of the notion "right to education" is imperishable. However, its meaning (content) changes with the development of society. Compulsory secondary education has long ceased to serve as the main indicator of the national education system (see e. g. Dewey, 1923). In 1937, John Dewey wrote 'School education is but one educational agency of many, and at the best is in some respects a minor educational force' (Dewey 1937). The system-forming element that determines the highest possible quality of education in the country is today the forming of highly qualified teaching personnel for the educational sphere (for HEI in the first place), which is provided by the national R&D system[3] (e.g. Leišytė L, 2016). The present report, on the basis of non-conventional indicators, evaluates the quality of PhDs training in each of EaP countries.

We also hope that by focusing research on the educational implications of R&D systems, we will draw more attention to them from the general public than by focusing on the importance of R&D for innovative development, good governance, etc.

Another critical area, detailed in the report, is the legal environment regulating research activities in EaP countries. To the best of our knowledge, a comparative analysis of it is done for the first time. In the report, the main normative documents regulating R&D activities in each of the

[2] Armenia did not take part in the study.

[3] There are many publications on the advisable teaching/research balance in universities, but one thing is clear: without research activity, the teacher cannot be formed.

countries are compared among themselves, as well as with their analogs in selected European countries using a sort of content analysis.

One more problem studied and presented in the report is migration of researchers, formation of scientific diasporas and 'brain drain' in EaP countries compared with selected post-socialist EU members.

Based on the analysis of the data obtained, conclusions related to the region as a whole are drawn and recommendations for improving policies of the EU and partner countries in relation to national R&D systems are presented.

The report consists of the following chapters:

1. General comparative overview of 6 national R&D systems in the EaP region based on conventional indicators, as well as on conclusions by the Horizon 2020 PSF missions for 4 countries.
2. Comparison of the regulatory / legal environment supporting the operation of national R&D systems in each of the EaP countries.
3. Human resource (human capital): the state of training and use of highly qualified R&D personnel, studied using original (our own) (non-conventional) bibliometric methods.
4. Discussion of the results of the first three chapters and formulation of conclusions and recommendations aimed at improving the R&D policy within the EaP Initiative.

*The first chapter* is mainly prepared by Dr. Nana Aslamazishvili (Georgia) and Dr. Sergiu Porcescu (Moldova).
*The second chapter* is mainly prepared by Dr. Volodymyr Nochvai and Dr. Kateryna Ivanchenko (Ukraine).
*The third chapter* is mainly prepared by Dr. Ineza Gagnidze (Georgia) and Dr. Oleg Shatberashvili (Georgia).
*The fourth chapter* was prepared by Dr. Volodymyr Nochvai, Dr. Sergiu Porcescu, and Dr. Oleg Shatberashvili.
A significant contribution to the preparation of the report was made by Dr. Karen Chilingaryan (Armenia) and Dr. Gayane Pogosyan (Armenia).

## Chapter 1
## State of national R&D systems of EaP countries

### *1.1. Analysis of the PSF reports and conclusions from them related to the EaP region as a whole*

The 2015 Annual Growth Survey (European Commission, 2019) identifies research and innovation (R&I) as one of the seven priorities for Member State structural reforms to boost investment and growth. In 2015 the European Commission had launched a new tool called Policy Support Facility (PSF) to help EU Member States and Associated Countries reform their research and innovation policies i.e. to identify, implement and evaluate those reforms needed to enhance their public funding, such as opening up public funding to competition and introducing performance assessments of universities, or stimulating cooperation between academia and business. It supports government officials to peer review the effectiveness of research and innovation

policies and provides access to independent high-level expertise and analysis. It is funded under Horizon 2020, the EU research and innovation programme with up to 20 million euro.

Association of the 4 EaP countries to H2020 Program offered them new opportunities, including a possibility to get external advice in performing reforms of the R&D sector. All of them applied to Horizon 2020 Policy Support Facility that gives Member States and countries associated to Horizon 2020 practical support to design, implement and evaluate reforms that enhance the quality of their research and innovation investments, policies and systems.

The Policy Support Facility provides best practice, independent high-level expertise and guidance at the request of Member States and Associated Countries through a number of services: *Peer Reviews, Mutual Learning Exercises and Specific Support to Countries*.

In 2015-2017 three PSF missions compiled of highly qualified experts from EU member countries had peer reviewed national RDI systems of Moldova (European Commission, 2016), Georgia (European Commission, 2018), Ukraine (European Commission, 2018), and Armenia (European Commission, 2020). The tasks of missions are presented in the Table 1.

*Table 1*

| | | |
|---|---|---|
| **Peer reviews**[4] | **Moldova (2016)** | The review focused on the following four main focus areas:<br>1. Increasing the **efficiency of public R&I funding** and the **quality of the R&I-performing bodies and instruments**;<br>2. Improving the policies for **human resources** and mobility of researchers;<br>3. Boosting **business innovativeness** and **science-business links**; and,<br>4. **Increasing R&I impact** by properly defining the policy instruments |
| | **Ukraine (2016)** | The focus areas of the Peer Review were the following:<br>1. Optimization of existing **policy instruments** to support the national research system including the **assessment** and advice on the tools introduced by the new Law on Scientific and Technical Activity, **mobility of researchers** and potential **priority research areas**.<br>2. **Internationalization** of research and integration of Ukraine into the European Research Area, including advice on how to better enhance the presence of the Ukrainian scientists and SMEs in European cooperation schemes.<br>3. **Role of science in the development of innovation** in Ukraine, including advice on how to improve the **links between science and business** and the innovation system in Ukraine. |
| **Specific** | **Georgia (2018)** | The task was to provide tailored advice and specific recommendations regarding three key areas of STI policy concern.<br>1. Support to **identify priority research fields**/areas<br>2. Proposal for introducing a **performance-based research funding** system (PRFS)<br>3. Suggesting measures for **narrowing the gap between research and industry/business** |

[4] Peer Reviews of national R&I systems are in-depth assessments of a country's R&I system carried out by a panel of experts and policy peers, leading to operational recommendations to the national authorities on the reforms necessary to strengthen their R&I systems. A Peer Review can take the shape of a general assessment of the country's strengths and weaknesses in R&I, but it can also focus on a number of specific elements of the R&I systems (e.g. reform of universities, knowledge-transfer system, etc.), as agreed with the country under review. It can be preceded by a 'pre peer review' (as a preparatory step to identify focus areas) and followed by a 'post peer review' (as a follow-up step to provide concrete advice on how to adjust and strengthen the implementation of the peer review recommendations).

| | | |
|---|---|---|
| **Support**[5] | **Armenia (2020)** | The team of experts was requested to provide recommendations and good practice examples on the following:<br>1. Development of a model for the **evaluation and assessment of the performance** of publicly funded research institutions;<br>2. **Assessment of the funding system** for research, **design of a performance based funding system** and advice on future implementation;<br>3. Measures to **bridge the gap between higher education and research systems** |

Table 1. The Policy Support Facility missions' tasks in EaP countries

The reports from these missions provided the starting platform for our research. The missions prepared a set of recommendations for each country. Our task was to identify those of them that were repeated in all 4 reports, i.e. applied to the entire EaP region.

Although the scope of the H2020 Policy Support Facility services requested by those 4 beneficiary countries were different, it could be easily concluded that they were facing similar challenges and, except very particular ones adjusted to the national context the majority of recommendations are also relevant to other EaP countries. Indeed, although the missions worked independently, out of 19 to 30 recommendations made for individual countries, 11 turned out to be identical, which underlines the similarity of problems in countries. The trends in the development of national R&D systems of the EaP countries in the light of these recommendations are discussed below.

The recommendations by PSF expert panels that could be considered common for all the countries under scrutiny are the following (in order of priority we assigned to each of them):

1. Increasing the level of public funding allocated to R&D activities, increasing the level of competitive funding and introducing performance-based funding component.
2. Increasing the attractiveness of research career, especially among youngsters.
3. Embed Research and Innovation (R&I) policy in the overall economic policy strategy, emphasizing the role of R&D for the modern development.
4. Create research and innovation information systems.
5. Strengthen the governance of the sector, assure participatory priority-setting, and concentrate resources around a limited number of scientific priorities.
6. Enhancing R&D capacities within the Universities and increasing their collaboration with the research institutes.
7. Assure coherence across R&I support measures: avoiding fragmentation and duplications, ensuring complementarities and a logic chain from research to innovation.
8. Improving research evaluation practices, introducing an international peer review system for projects.
9. Developing Research Infrastructure roadmaps, opening up RI from the public sector for the business.

[5] Specific support to countries provides tailored advice, expertise, and good practice to help Member States and Associated Countries in the design or implementation of a specific reform concerning R&I strategies, programmes or institutions. This tailored support provides concrete recommendations on how to tackle a specific R&I policy challenge and how to implement the accompanying reforms.

10. Develop the framework conditions for innovation and for business engagement in the R&D activities.
11. Further stimulation of the international collaboration.

At the same time, on some of the fundamental issues, which are obviously also identical in all countries, the positions of individual missions diverged significantly. This is confusing, so we consider it necessary to comment on this circumstance. An example is given in the Box 1.

Box 1

**The roles of the Academies of Sciences in EaP countries**

One common legacy inherited by the current R&D systems of the EaP countries is the institution of the Academy of Sciences. Though all of them originated from the same system before the collapse of the Soviet Union, during the last three decades different institutional models of them were implemented in the region (Academy of Sciences as a policy maker, very influential research performing organization or learning society).

At the moment of PSF Peer Review, in 2015-2016, the Academy of Sciences of **Moldova** (ASM) was combining the role of a policy-maker, funding agency and major research performer in the country. The Policy Support Facility Peer Review Panel recommended to establish a Ministerial responsibility for R&I policy and to combine it with an independent Agency that manages R&I funds. This would allow the Moldovan Academy of Sciences to focus on its role as major research performer in the country, providing that the research capacity in ASM is maintained, and therefore ASM remains in possession of its research-devoted assets and infrastructure, including buildings and land. One year later, Moldovan authorities passed all the policy-making competencies to the Ministry of education and culture (which became also of research (MECR)) and created the National R&D Agency, which is managing currently the competitive funding. In the same time, the academic research institutes were transferred to the MECR, so, ***currently ASM took the form of a learning society***.

In the case of **Ukraine**, the expert panel recommended in 2016 to the National Academy of Sciences of Ukraine, the dominant research organisation in the country, to streamline its profile, concentrate its priority focus and to make its institutes' organisation more effective through regular independent evaluation exercises *(**no recommendation to transform Academy of Sciences into learned society**)*.

Not the same was the situation in **Georgia**, where the institutes of the National Academy of Sciences were transferred to the Universities long before the PSF mission came. Even more, institutes were deprived of the legal entity statutes and property, becoming just structural divisions of universities. In this case the mission recommended finalizing the reform of the Academy (which ***already became a learned society*** having no institutes), as well as finalizing the integration of RIs into universities that was remaining largely formal. It is ***surprising because 10 years of Georgian 'experiment' gave evidently negative results*.** Some of its outcomes are given in the Box 2. Georgian experience as a negative one is mentioned in the PSF mission report on Armenia (European Commission, 2020, p. 37).

One of the conclusions of the Specific Support to **Armenia** panel was to change, gradually, the

role of the National Academy of Science, which should become a learned society as in most European countries. The NAS research institutes network should become, over time, legally independent (becoming a network of autonomous public research organizations, merging into universities, etc.) from the NAS. The legal status and governance structure of the NAS RIs should be adopted over the coming three to five years. The NAS should retain and develop certain functions such as scientific information and advisory services, science diplomacy role, etc. Thus, ***it is recommended to turn NAS into a learned society***.

It is necessary to comment on this apparent discrepancy in the recommendations of the 4 missions in relation to the same objects (NAS) in similar conditions. The background for the desire to reorganize NASs is the accumulated dissatisfaction in the EaP countries with their activities, which has both an objective and a subjective basis. On the one hand, NASs, which operated very effectively in the 50s-70s of the last century, lost their former energy and adherence to principles, recruited into their ranks (members of academies) many people who can hardly be called scientists, organizers of science or research leaders. This reduced the effectiveness of the scientific organizations entrusted to them, which was exacerbated by the dramatic underfunding of the last 30 years. On the other hand, in each of the countries there are forces that are interested not so much in increasing the efficiency of scientific institutions, but in transferring property and financial flows to other hands, from which high requirements to be leading scientists will not be demanded. This is the subjective basis.

Therefore, the discussion often boils down to a discussion of the subordination of research institutes, and not the organization of an extra-university government sector of science, the existence of which is a world practice. Without going into the details of justifying the need for this sector, we note that in its variants implemented in different countries, associations of research institutes are self-governing (managed by outstanding scientists), and not administratively managed. Examples are Max Planck Society and Fraunhofer Society (Germany), Łukasiewicz Research Network and Polish Academy of Science (Poland), CNRS (France), National Labs (USA), and the USSR Academy of Sciences, the successors of which are the national academies of EaP countries.

Box 2

**The consequences of R&D sector reform in Georgia**

Research institutes, deprived of legal entity statutes, cannot purchase themselves even smallest services. Any deal or contract need the signature of the university administration located sometimes far away from the institute. Besides inconveniencies, sometimes serious disruptions to normal functioning emerge.

For example, in Georgian Technical University subordinated institutes do not have connection to Internet in the first half of a year during 4 consequent years because the university buys service for about 20 institutes altogether, so this large contract falls under the public procurement law, needs announcement of a tender and makes the procedure very slow.

Sometimes selected institutes are ‘awarded’ legal entity statute as a gift. At the Ilia State

University in 2020 one of about 15 institutes – Abastumany Astrophysical Observatory – have been given back the legal entity statute because the Abastumany area where it is located was chosen for development of tourism. It seems the Observatory became one of the tourist attractions sites. Its statute has been 'increased' also by taking the Observatory from the university and subordinating it directly to the Ministry of Education and Science.

Georgian reform gives plenty of such examples.

The requirements for the quality of specific people to whom large groups of scientific institutions are transferred for management cannot be ignored. PSF mission in Georgia noted this. After meeting with the leadership of all universities to which NAS institutes were transferred, it concluded: ". ... in reality, ... University leadership appears to have little experience as 'academic entrepreneurs'". Using bibliographic databases, we checked the academic level of rectors of leading national universities in EaP countries and found that their majority do not meet the Highly Qualified Researcher (HQR) requirement that we have formulated (Chapter 3). Therefore, the PSF observation of the mission in Georgia is relevant for the entire EaP region. What has been said about university leaders should also apply to the leadership of ministries and agencies, to which institutions are transferred in some countries (for example, in Moldova).

The PSF mission in Ukraine concluded that 'If the reforms triggered by the new Law on Scientific and Technical Activity[6] do not receive the highest attention and support by government and stakeholders, it is highly probable that Ukraine will lose its connectivity to international STI progress' (European Commission, 2017, p. 8). This is a highly relevant statement that holds true for all EaP countries. One can only regret that it was not formulated in such a form in the reports on Armenia, Georgia and Moldova. We will rephrase it this way:

**If the governments and stakeholders in EaP countries will not pay the highest attention and provide the greatest support to the national R&D systems, it is highly probable that the EaP countries will lose their connectivity to international STI progress.**

In other words, the EaP countries, using only non-R&D-based innovation channels, at best, will reach an economic level of 10-12 thousand Euros per capita over the next 10 years and stop growing there. By this time, if R&D systems continue to follow today's trajectory, they will fizzle out. The education system will suffer serious damage (see Chapter 3). The intellectual part of the middle class will be completely washed out, which will negatively affect the quality of countries' governance. By being close to the rich countries of the European Union and comparing themselves to them, they can become a permanent hotbed of political crises and instability, creating problems for the EU. Even with political will, it will take a generation (about 20 years) to correct the situation. In this sense, the EU should also be concerned about the current situation. Thus, the rehabilitation of national R&D systems is in the interests of both EaP and EU countries. The question is, what needs to be done so that the governments of the countries and the European Commission are equally acutely aware of these interests?

[6] This refers to the Ukrainian Law on scientific and scientific and technology activities, 2015.

It seems that EU actions in the field of R&D policy can be built by analogy with those carried out in the fields of democracy and human rights, where in the EaP countries, despite the difficulties, there is the obvious progress, especially in comparison with the period of the USSR. This approach will be fair and appropriate if we remember that R&D systems in the world play an increasing role in education, the right to which belongs to fundamental human rights. We are confident that at this stage, and taking into account the real state of EaP R&D systems, the educational rather than the innovative role of R&D systems should be highlighted (not forgetting, of course, the latter)[7]. This is fair and effective, since we are automatically talking also about the rehabilitation of the education system, strengthening the middle class and improving the quality of governance.

To one degree or another, PSF missions in all 4 countries noted the problems in the field of R&D human resources - the most valuable and, at the same time, very slowly accumulating asset of R&D systems. The aging staff, lack of youth inflow and brain drain that they noted applies to all countries, including Azerbaijan and Belarus. Our research supplemented their reasoning with an assessment of the quality of human resources in the EaP countries. The results are summarized in Chapter 3.

We also continued the study and assessment of R&D governance in EaP countries initiated by PSF missions in Armenia, Georgia, Moldova and Ukraine. In the Chapter 2 we present the result of a comparison of the basic laws governing this area.

### *1.2. Comparison of the state of the national R&D systems of EaP countries among themselves and with selected (individual) EU countries based on conventional indicators*

All PSF missions reported dramatically low levels of funding for R&D systems (GERD) in Armenia, Georgia, Moldova and Ukraine. As seen in Fig. 1, this conclusion can be extended to Azerbaijan and Belarus as well. Note that although the data shown in Fig. 1 describe the interval 2010-2017, the previous interval between 1990 and 2010 was characterized in all countries by similar and even worse GERD values. We do not present them just because they are irregular and have significant gaps: for some countries are missing some years, for others – other years.

[7] According to Malyckyi (2007)

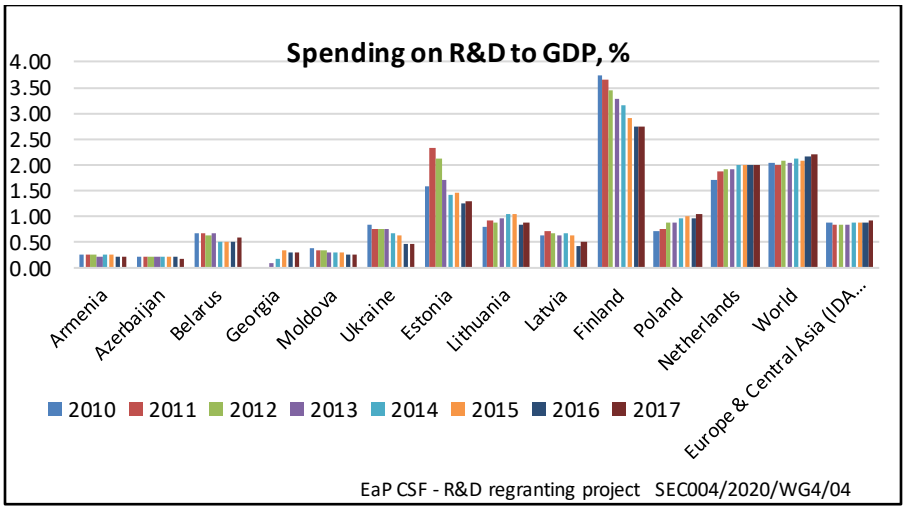


Figure: 1. Dynamics of R&D expenditures in EaP countries in comparison with other countries and regions (Source: https://data.worldbank.org/indicator/GF.XPD.BUDG.ZS)

The above information was communicated by the PSF missions to the government of Moldova in 2015, to the government of Ukraine in 2016, and to the government of Georgia in 2017. However, the situation did not improve in the following years. On the contrary, in 2020, funding for science in Georgia decreased by 10% compared to 2019, in Moldova and Ukraine – is left at the same level.

The unfavorable funding regime has determined the values of other indicators of national R&D systems in the EaP region: for example, scientific production (Figure 2) and the number of R&D personnel (Fig. 3 and 4). More characteristics of the national RDI systems of EaP countries are given in the Annex 1. In the Chapter 3 we also consider some data on the quality of R&D personnel, namely quality of researchers.

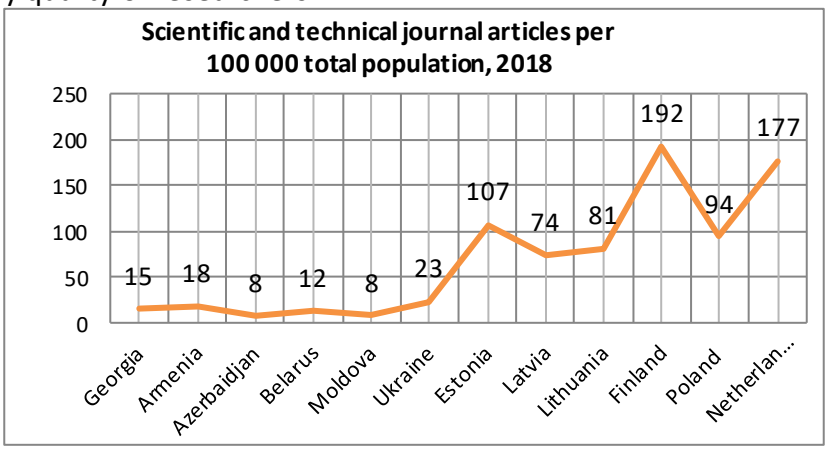


Figure 2. Scientific productivity of EaP and selected EU countries (Source: https://knoema.com/)

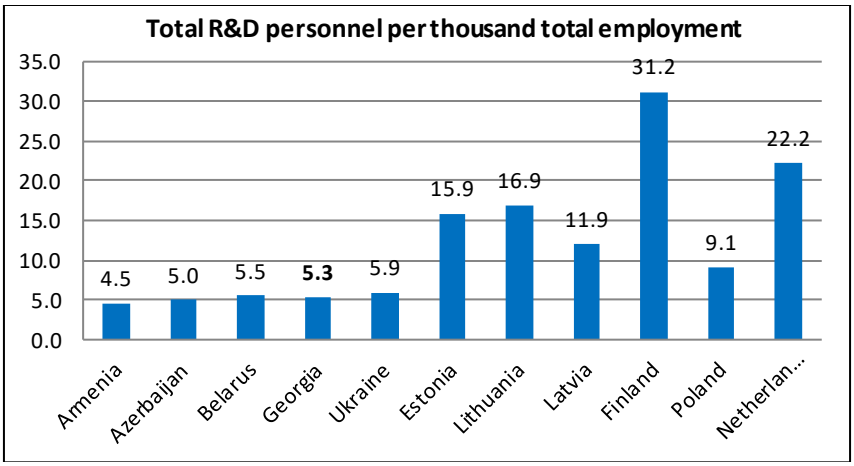


Figure 3. Comparison of R&D personnel, average for 2012-2016 (Source: https://knoema.com/WBWDI2019Jan/world-development-indicators-wdi)

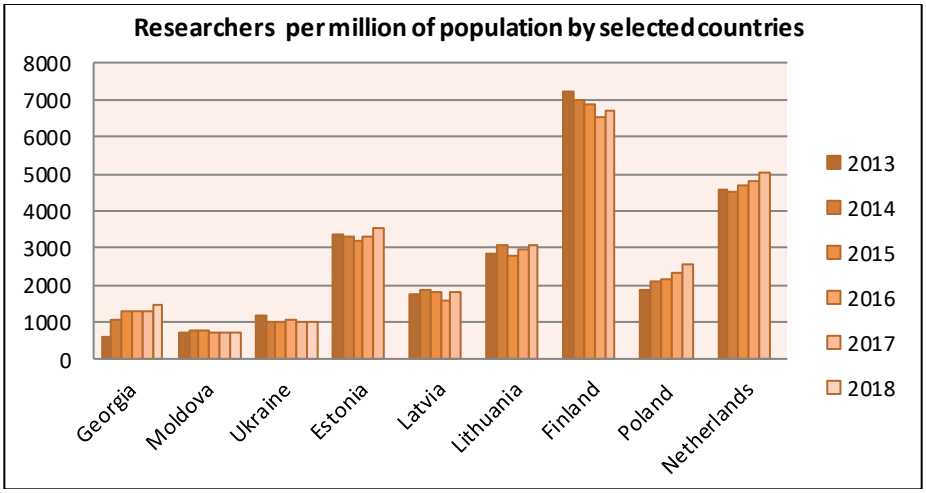


Figure: 4. Dynamics of the number of scientists per million inhabitants (Source: https://knoema.com/WBWDI2019Jan/world-development-indicators-wdi)

Obviously, the numerical values of all indicators of the EaP countries lag behind even the former republics of the USSR (Latvia, Lithuania and Estonia). It is also obvious that the values for EaP countries are close to each other. Unfortunately, some data for Armenia, Azerbaijan and Moldova are not available, but since the nature of the data is the same for all, significant deviations are unlikely to be expected. This fact cannot influence the reasoning and conclusions.

Below, in Chapters 2 and 3, we present some estimates of (a) the quality of management of EaP R&D systems and (b) human capital in these systems, obtained using non-standard research methods.

*1.3. Conclusions from Chapter 1*

**In EaP countries, including the countries that signed the Association Agreements, an atmosphere of many years negligence of national R&D systems has been created, putting them**

**in jeopardy of complete collapse, which will also entail the drop of education systems that are already quite weakened compared to the period of the USSR.**

PSF missions have articulated the shortcomings of the national R&D systems of EaP countries in a concentrated and dramatic manner. But even earlier, within the framework of EU FP6, FP7 and Horizon2020 programs' numerous INCO international projects aimed at strengthening RDI systems, the governments of the EaP countries received information about their unsatisfactory state. However, there is no positive reaction. Of course, there are other areas too, for example, economic (including those comprised by the signatory countries in the Association Agreement Action Plans and DCFTAs[8]), in which governments do not fully fulfill their obligations. But in these areas, intensive investment can quickly remedy the situation. In the field of R&D and the closely related field of education, the speed of correction/rehabilitation is limited by the ability of people to assimilate knowledge, i.e. it cannot be as high as in the economy.

The trends in EaP national R&D systems are in sharp discrepancy the EU ones where number of researchers has increased by one-third (35%) between 2007 and 2017, reaching from 1.46 to 1.97 million (Eurostat 2019).

**Special measures are required to turn the tide of events in order to prevent a delay in development of these countries for at least 20 years and political crises on the eastern borders of the EU.**

The similarities of the indicators of the national R&D systems of the EaP countries, as well as the similarity of the motives and actions of their governments, which led to the low indicators, point at the possibility of developing such measures for the entire region.

## Chapter 2
## The state of the legislative (regulatory) framework for the functioning of the national R&D systems of EaP countries

### *2.1. Comparative analysis of fundamental laws on science and scientific activity in EaP countries*

In the 20th century, when R&D acquired a national scale and a generally recognized role in the development of countries, the management of R&D systems became an important part of public administration. In the 21st century, the quality of management of national R&D systems is the quality of the future that the nation plans for itself. According to the considerable experience gained by humanity in this area, quality is determined, along with the qualifications of people

[8] Deep and Comprehensive Free Trade Agreements (https://ec.europa.eu/trade/policy/countries-and-regions/negotiations-and-agreements/)

managing the R&D system, by legislation establishing the management scheme, subjects and objects of management, the roles of stakeholders, and the rules for interaction between them.

Scientific activity in all countries of the Eastern Partnership is regulated either by a law on the field of science (Azerbaijan, Belarus) or science and technology (Ukraine, Georgia, Armenia). Concerning Moldova, the law also regulates the scope of innovation in addition to the field of science.

All EaP countries' laws have declared **the state obligations** for support and development of science and technology as a purpose of the state policy.

We have analyzed the core laws in force in each country, comparing them with each other and with similar laws in some post-socialist EU countries. In the Table 2 these laws are given.

| Country | Title |
|---|---|
| Armenia | Law on Scientific and Technological Activity, 2000 |
| Azerbaijan | Law of Republic of Azerbaijan on Science, 2016 |
| Belarus | Law of Republic of Belarus on Scientific Activity, 2005 |
| Georgia | Law on Science, Technology and their Development (1997 with amendments) |
| Moldova | Code on Science and Innovation, 2004 |
| Ukraine | Law on Scientific and Scientific and Technology Activities, 2015 |
| | On the peculiarities of the legal regime of the National Academy of Sciences of Ukraine, national branch academies of sciences and the status of their property complex, 2002 |
| Estonia | Organization of Research and Development Act, 2014 |
| Poland | Law On higher education and science activities, 2018. |
| | ACT on the Polish Academy of Sciences, 2010 |
| | ACT on the Lukasevicz Network, 2019 |

Table 2. The core laws regulating R&D activities in EaP and the reference EU countries

### *2.1.1. Method*

To compare laws, we used a variation of the content analysis method. The analysis involved, first of all, the core laws on R&D with slightly different names in different EaP countries, but the same goal.

If the law concerned science and education, as, for example, in Poland, we considered only those articles of the law that relate to R&D.

### *2.1.2. Comparison of laws by volume*

The first step was a simple, formal comparison of laws by volume measured by the number of words contained in a law. The result is shown on the Figure 5.

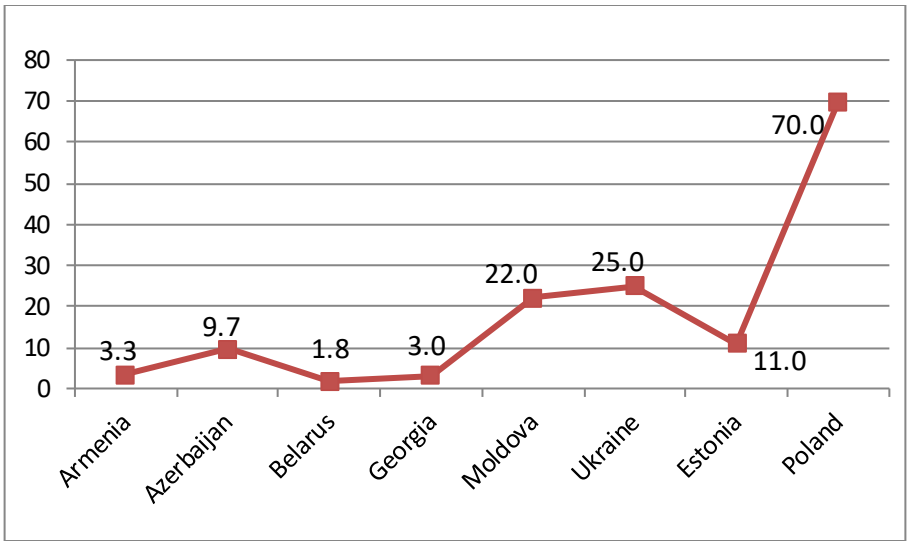


Fig. 5. Word count of EaP countries' laws on R&D, thousands

There is a wide variation in the volume of core laws. The question arises: how can such very different laws regulate the same object with the same efficiency? The size of the law can, of course, be influenced by the scale of the country (for example, due to a more complex administrative division and the need to describe the rights and responsibilities of a larger number of subjects), but not to such an extent. There is a set of questions that the law is obliged to answer, regardless of the size of the country. The next step in our analysis will explain the cause of differences observed.

*2.1.3. Comparison of laws by content*

Based on the most comprehensive laws - Polish and Ukrainian - we compiled a rubricator of topics covered by a "hypothetical" law on science and technology, and then compared each national law with the rubricator for the presence/absence of rubricator's items in it, marking presence with "yes" and absence with "no". That is, we did not ask the questions "how does it answer", "to what extent does it answer", etc. As expected, there were many thematic gaps in the laws, and in addition, different laws contain a significantly different number of articles on the same issue.

Examples of legal gaps are given in Box 3, and a complete table of compliance of national laws with the rubricator is given in Annex 2.

Box 3

**Examples of legal gaps in the national R&D laws of EaP countries**

An important issue of **Science and Technology advisory and coordination bodies at the national level** is regulated in laws of Ukraine, Belarus, Moldova, and Azerbaijan. In Armenia and Georgia, it is not mentioned by the law (although in the latter it exists, headed by the prime-minister).

The **Research infrastructure other than research institutions** is regulated by laws only in

Ukraine, Moldova and Azerbaijan.

Neither the **research organizations, nor associations of scientists in the civil society sector** are considered by law in Belarus.

In most of EaP countries the law establishes a requirement for **high salaries for scientists,** although particular formulations vary from very concreate (even too concreate) to very vague. Governments are **responsible for implementation of the laws,** but numerous examples of non-implementation are given in the Chapter 1.

In some of the countries the law establishes a requirement for **growth of GERD**. In Armenia it is formulated as 'at least three percent of the annual expenditures of the state budget' and in Ukraine as 'ensuring by 2025 an increase in funding for science from all sources up to 3 percent of GDP' of which not less than 1.7 percent from the state budget. (The non-execution of the demands by governments is seen in the Chapter 1.).

While the laws in Ukraine, Armenia, and Azerbaijan define in details the **notion of 'scientific activity'**, as well **as the notion of 'scientist'**, distinguishing it from the **notion of an 'employee of scientific organization'**, others touch this issue superficially, and Georgia does not define the notions at all.

In all national laws the **functions and responsibilities of Ministries of Education and Science** and **Academies of Sciences** are defined to this or that extent. Although, in most of them **the role of other executive bodies** (like line ministries, agencies, local authorities, etc.) in R&D sphere are not mentioned at all.

In some countries, the **legal status of scientific organizations is not defined** by the law (for example, in Georgia).

*2.1.4. Comparative analysis of regulations providing the branch management of RDI*

The above data obtained, nevertheless, may leave doubts of the following kind: whether the details of the regulation of the R&D sphere in countries with too schematic core laws have been delegated to by-laws, regulations of branch ministries, etc. To make sure that the obtained characteristics of laws in the EaP countries indicating their low quality are reliable, we checked another set of available documents characterizing the involvement of branch ministries in the management of the R&D sphere. Already in the 20th, and even more so in the 21st century, sectoral and regional management cannot but rely on research. This fact should be reflected in the regulations on/ statutes of each ministry and department. Therefore, we studied the statutes of EaP countries' ministries from this point of view.

The involvement of branch ministries can be expressed in the form of declaration of the ministry's aspiration to manage on the basis of scientific analysis, in fulfilling the role of commissioner of research, or in owning their own scientific organizations. We have studied the statutes of ministries using the same formal method of content analysis. We used three indicators as evidence of the ministry's involvement in R&D activities:

1. Financing of scientific researches, ordering them, etc.

2. Conducting / coordinating / supporting research, participating in scientific activities
3. Using scientific advice and involving researchers as experts in the decision-making process.

If at least one of these 3 forms of activity is noted in the statute of the ministry, we consider that the ministry is involved in the management of R&D to one degree or another. The detailed result of analysis is given in the table of Annex 3. We have used three involvement measures:

1. Functions in R&D sphere are clearly defined in the statute (marked in green in the table)
2. Functions in R&D sphere are just mentioned in the statute (marked in yellow in the table)
3. Functions in R&D sphere are not mentioned in the statute (marked in red in the table).

The statutes of 86 ministries from all EaP countries were analyzed. The R&D functions are clearly defined only in 27 statutes. In 9 statutes R&D functions are not mentioned at all. In the rest the R&D functions are poorly reflected (only mentioned without any detailing). This is not surprising since, as noted above, the core national R&D laws in the most cases do not contain articles reflecting the role of branch ministries, thus not inviting them to participate in the management of R&D systems.

Box 4

**Examples of flaws related to R&D functions in statutes of branch ministries of EaP countries**

The functions in the field of R&D **are not indicated** in the statutes of such ministries as Economy (Armenia), Finance (Armenia), Foreign Affairs (Armenia), Defense (Azerbaijan), i.e. those which would be expected to have them.

Contrary to expectations, the R&D functions in the statutes of the Ministry of Digital Transformation (Ukraine), as well as the Belarusian ministries of Communications and Informatization, Transport and Communications, Architecture and Construction **are poorly defined.**

R&D functions are also **poorly defined** in the statutes of Ministries of Defense of Belarus, Moldova, Armenia and Georgia (despite the fact that the latter has 6 research institutes under its jurisdiction).

Unexpectedly **poorly reflected** are R&D functions in statutes of the Ministries of Health of Ukraine, Moldova, Armenia and Georgia (despite the fact that in Georgia the Ministry of Health spends 1/3 of GERD).

In difference from statutes of the EU member states' branch ministries, the statutes of EaP countries' ministries do not contain enumeration of functions which the ministry fulfils in cooperation with other ministries. It is evident that the process of drafting of the individual ministries' statutes in EaP countries is not harmonized and leads to inefficiency in management of the cross-sectoral issues like R&D.

### *2.2. Conclusions from Chapter 2*

We deliberately did not set ourselves the goal of ranking the EaP countries in terms of the quality of legislation. It can only be noted that Ukraine is clearly ahead of others in terms of coverage of relevant issues and detailing of wording. It also, unlike other countries, timely (in 2002) adopted a

special law on the protection of the property of the Academy of Sciences, which saved research institutes.

In general, it is obvious that:

1. The quality of R&D laws of EaP countries is unsatisfactory.
2. In many countries, laws do not cover the minimum range of issues required to govern R&D.
3. The level of detail of the chapters of laws does not correspond to that usual in successful post-socialist EU countries.
4. Laws, as well as regulations concerning ministries, as well as statutes of ministries often do not facilitate their involvement in R&D management.
5. **Legislators in EaP countries need serious methodological assistance in developing laws and regulations related to R&D.**

## Chapter 3
## The state of human resources in R&D in EaP countries
## (Quality of human resources)

### *3.1. Introduction to Chapter 3*

The most acute problems for the R&D systems of the EaP countries arose in connection with human resources - the most valuable and, at the same time, very slowly accumulating asset of the R&D systems. These problems, - aging R&D personnel, lack of youth influx, and brain drain - noted to varying degrees by PSF missions in 4 countries (Armenia, Azerbaijan, Georgia and Ukraine) apply to all 6 EaP countries. Our research differs from the previous ones in that **we assess not only quantitative, but also qualitative changes in human resources on the basis of new original bibliometric methods and indicators.**

In general, the EaP region is characterized by a tremendous and continuous decline in R&D personnel since 1990. There are no complete and regular data for the past 30 years, however, based on data from various sources for different years, it can be concluded that the number of personnel in scientific organizations in the region has decreased, depending on the country, from 2 to 12 times (the largest reduction in Georgia, the smallest in Belarus)[9].

Long-term underfunding has shifted scientists from the upper quarter of the middle class to the lower, and in some of the countries under review, even to the category of the poor[10]. The work in science has become not prestigious, therefore, unattractive for the younger generation. The result was an unacceptable aging of research personnel. There was also a sharp outflow of young employees, primarily the most capable. All PSF missions noted this in their reports (most prominently in the Ukrainian, Moldavian and Armenian ones).

The outflow took place through several channels:

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[9] In Ukraine, the number of R&D personnel decreased from 400 thousand (1990) to 100 thousand (2018), in Moldova - from 25 thousand (1990) to 3.7 thousand (2018), in Georgia from 40 thousand (1990) to 3.5 thousand (2018).

[10] In 2015 the average Armenian salary was USD 364, while the average NAS salary was USD 250 (Inco-Net EaP. S&T Policy Mix Peer Review Armenia, 2015). In 2020 the average Georgian salary is EUR 320, while the average salary in research institutes is EUR 220.

- Transition to the private sector with a simultaneous cessation of scientific activities;
- Transition completely to the teaching work with the actual termination of scientific activity;
- Transfer to foreign scientific organizations and universities (formation of a scientific diaspora);
- Transition to international organizations and projects;
- Transition to non-governmental organizations of civil society with partial or complete cessation of scientific activity;
- Transition to administrative work and careers in politics.

Everywhere they showed themselves from the best side and contributed to new for them areas of activity. Thus, people formed in the national scientific environment are in a great demand. The task is to create working conditions for them in the scientific environment itself.

The transition process to other areas is not beneficial for R&D systems. However, if it is within reasonable limits, it is positive for society as a whole, since it feeds various fields of activity with highly qualified personnel. Due to the aging of scientific personnel, this feeding also has practically stopped in EaP countries, which will negatively affect the development of society as a whole. Thus, science gradually ceases to play an essential role in public life. Although in cases where it is approached, it still demonstrates its capabilities (Box 3).

Box 5

**Recent efficient responses to societal challenges by national R&D systems**

**Moldova.** In Moldova, in the context of the COVID-19, on 27th of April, Nicolae Testemitanu State University of Medicine and Pharmacy (SUMPh), launched the National Research Platform "COVID-19" in order "to research the complexity of the current situation linked with the spreading of the virus and to advice the policy makers on measures, strategies and interventions that will allow the country to tackle the consequences of the pandemic with minimal losses". A call to researchers from other scientific fields was launched, in order to join forces and to work within interdisciplinary teams. As a result, around 50 project proposals, covering different aspects and consequences of the COVID-19 pandemic were submitted to be part of the afore-mentioned research platform. The representatives of the Platform are actively involved in the work of the National Emergency Commission of Public Health, where the COVID-19 epidemiological situation, evolution trends and corresponding decisions are daily examined.

**Georgia.** Georgia has passed relatively mildly the first period (March-August, 2020) since the beginning of the COVID-19 pandemic to October 2020, both in terms of the number of infections and the number of deaths. It is the result of R&D system's activity. Fortunately, it so happened that the epidemiology and virology service (National Center for Disease Control and Public Health) was seriously reinforced several years ago by a well-equipped virology laboratory known as the Lugar Lab, named after US Senator Richard Green Lugar who initiated the creation of the laboratory. The service has become a competent and prestigious part of

the national R&D system, capable of competently planning prevention and treatment activities and advising the government[11].

A particular danger is the termination of the feed of the education system from the research sphere. Removing R&D from the educational chain shown in Fig. 6, leads to a drop in the quality of the entire educational system. It is currently observed in the EaP countries, especially in connection with the expansion of the networks of private universities requiring more and more teachers. The demand for professors is growing, and the opportunity to train them is diminishing.


Figure 6. Research – education chain

Therefore, we have put special emphasis on R&D human resources in their projection on education and, using new original bibliometric methods, have studied some characteristics of processes quantitatively.

*3.2. Method of the study*

Our aim was to describe quantitatively what is the community of remaining researchers in each country, namely: age; qualification; gender composition; the ratio of their number to the number of researchers in the emerged scientific diasporas.

The research method consists in creating statistically significant samples of researchers from a bibliographic database based on the surnames ethnically related to a given country (surname-based sampling). Such a sample is analyzed, and the result is extended to the entire population of researchers (see the example in the Box 6). The method is described in the article by O. Shatberashvili (2019).

In our study "Researcher" is a person who publishes scientific articles, patents, etc., indexed in a bibliographic database (DB) containing citation indicators. We used the Google Scholar database (Scopus or Web of Science DBs could also be used)[12].

Box 6

**An example of application of the surname-based sampling in bibliometric study**

Let's say we are studying Moldova. We choose a typical Moldovan surname, for example

[11] On the later stage, the second wave of COVID-19 hit Georgia severely, but it was not the fault of the scientists.

[12] In the case of using Scopus or Web of Science DBs, the definition of Highly Qualified Researcher (HQR) will change, but the result of comparison between countries will be the same.

"Ceban". We know that there are about 20,000 people living in Moldova bearing this surname and they make up 1/174 of the population of Moldova. We select from the bibliographic database all researchers bearing this surname, which is not technically difficult to do. At the same time, we fix for each selected researcher all the features of interest to us: affiliation, discipline, year of first publication (to determine age - see below), maximum citation of one article, gender, etc.

We analyze the sample for all selected features and extend the result to the entire population of scientists, and if necessary, to the entire population of Moldova. The sample will include all "Ceban" living in Moldova and abroad. Separating these two groups, we get the numbers of local and diaspora researchers, etc. We can also set the time interval that interests us. For example, the "Ceban" researchers who published in 1995-98 and the "Ceban" researchers who published in 2015-18. Comparison of these two samples makes it possible to judge the change of features of interest over time.

If we want to improve the accuracy of the results, we choose not one, but several surnames, thus increasing the sample size.

It should be noted that the bibliometric approach characterizes only the researchers, and not the entire R&D personnel, and, also, that the samples include all researchers from all sectors: research institutes, universities, industry, civil sector, etc. Further, one can divide the sample into subsets according to these characteristics, but we did not do it within the framework of this particular project because of time and volume limits. This must be borne in mind.

We were especially interested in indicators for highly qualified scientists, who can be leaders in research or occupy the position of professors and higher in higher education institutions. To determine qualifications, we used the concept of Highly Qualified Researcher (HQR) (Shatberashvili, 2019) - independent of the country, in contrast to the academic degree (PhD), the requirements for which, as measurements showed, differ significantly in different countries. As it turned out, it is incorrect to compare countries by the number of PhDs (see Fig. 9).

We use the following definition of HQR: the HQR is a researcher who has published at least one article cited 30 or more times. In terms of conventional citation rates, this indicator statistically (on average) corresponds to a scientist with the Hirsh Index h≥4 in Google Scholar, but individually HQR is a higher indicator, since not all researchers with an h≥4 index have published articles cited 30 or more times. The Hirsh Index itself is technically inconvenient for our type of research.

Doctoral degree holders and HQRs are collectively referred to as "experienced researchers". A PhD holder may or may not belong to the set of HQRs. Conversely, an HQR may not have a doctorate, although this is rare.

*3.3. Age of researchers*

Our method allows, using a large bibliographic database, to calculate the average age of researchers in each country. We defined it in each country for the research community as a whole, without identifying the sector of affiliation of researchers (i.e. research institute,

university, enterprise, NGO, etc.). For research institutes alone, the result may be different (the average age is likely to be higher).

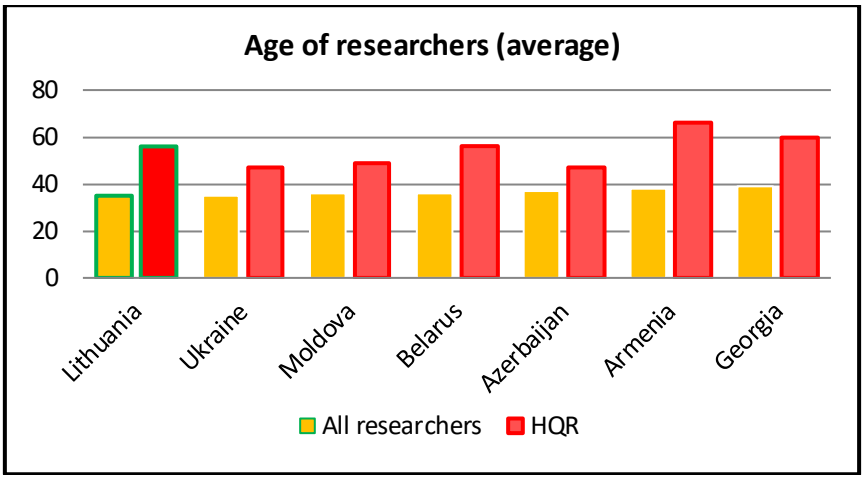



Fig. 7. The average age of researchers

As can be seen in Fig. 7, the average age differs little by research system in individual countries. But the average age of HQRs varies significantly. We consider HQRs' age, as well as other data on HQRs to be very important as it strongly influences the quality of R&D and education systems.

*3.4. Quality of human resources*

HQRs are those researchers who are capable of formulating research problems and leading research teams. They make university professors and science organizers, head of labs and research group leaders. An important characteristic of the R&D system is the share of HQR in the total number of researchers, as well as its change over time. In Fig. 8 these characteristics are given for EaP countries, Lithuania and Poland, as reference countries.

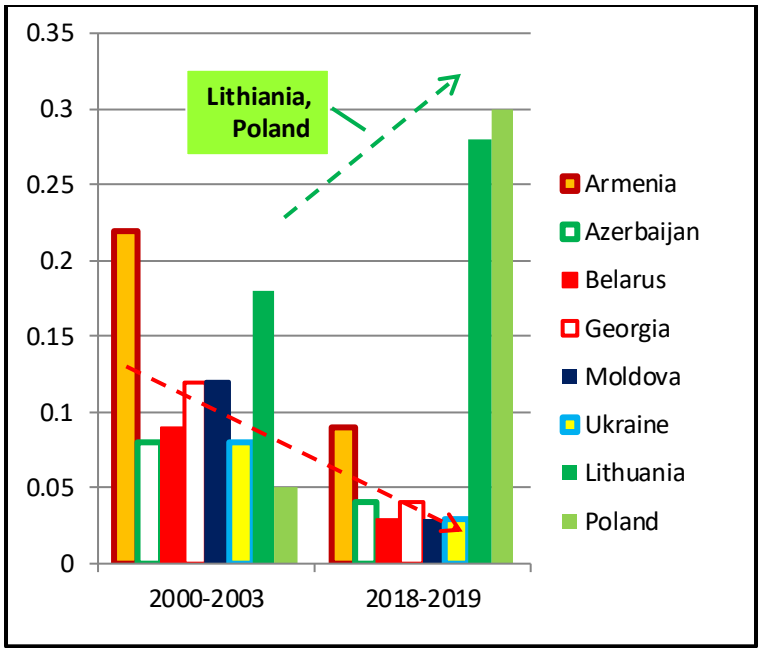



Figure 8. Time change of the HQR share among all local researchers

**The decline in the share of HQR, along with its low value, represents the greatest risk for the future of R&D systems in the EaP countries.** A good value of the HQR share is what Lithuania and Poland are striving for, and a good trend would be growth of HQR share in EaP countries.

*3.5. The ratio of the numbers of PhD and HQR (the quality of training for doctors of science)*

Using the method described above, we determined the number of HQRs in each of the EaP countries, the Baltic countries and Finland, and also found in various sources the number of doctoral holders in these countries. The diagram (Fig. 9) contains these data recalculated per 1,000 inhabitants.

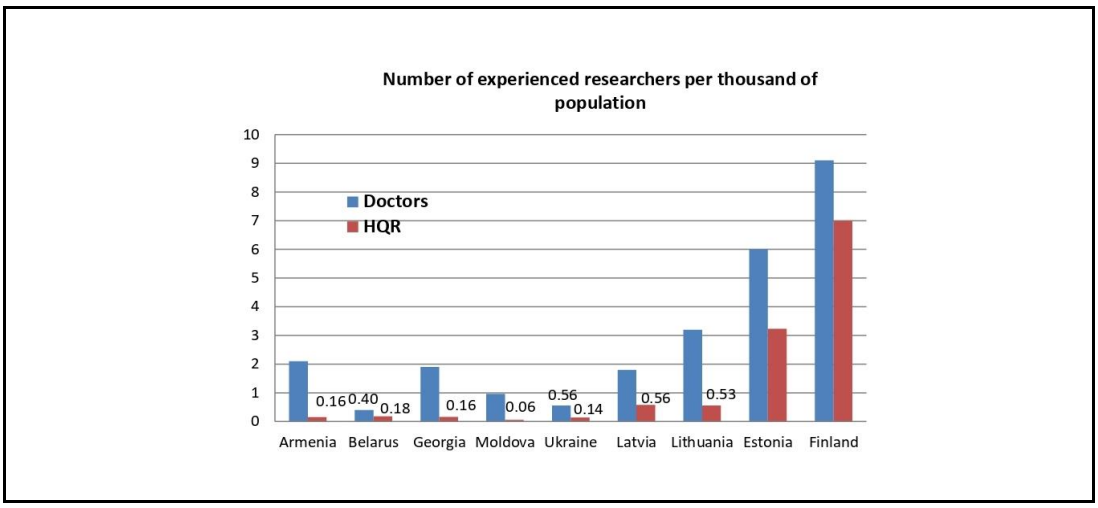



Figure 9. Numbers of experienced researchers per thousand of population

We failed to find data for Azerbaijan. Small values for Belarus and Ukraine in the Fig. 9 are associated with a two-stage system of scientific degrees - "candidate of sciences" and "doctor of sciences" (*Doctor habilitatus* in some countries) - which these countries retained in the post-Soviet period. For these 2 countries we managed to find data only for “doctors of sciences”, smaller, of course, per thousand inhabitants than ordinary PhDs, the number of which was used for Armenia, Georgia and Moldova. Accordingly, Belarus and Ukraine have the best indicators of the ratio of the number of doctors to the number of HQRs shown in Fig. 10. It should be noted that Armenia and Moldova also retained the two-stage system of scientific degrees, while in Georgia it was canceled - only the PhD degree was introduced.

It is significant that even in Belarus and Ukraine, not to mention the rest of EaP countries, the proportion of doctors who are HQR is lower than in single-stage Estonia and Finland. We can conclude that in Armenia, Georgia and Moldova, the quality of training for doctors (PhD) is unsatisfactory (i.e., the requirements for dissertations are understated). It is evident also that requirements to PhD are more important factor than number of stages. This explains the increase in the number of doctoral theses (PhD) defenses observed in all EaP countries in the context of reducing spending on research. It leads to a decrease not only in the quality of doctors of science, but also of the national education system.

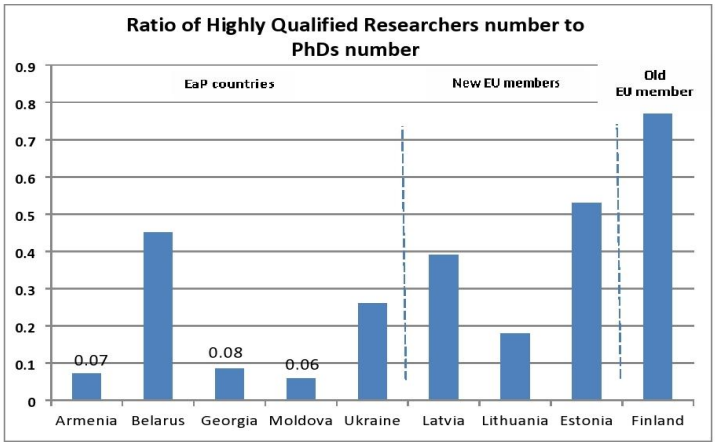



Figure 10. Ratio of numbers of Highly Qualified Researchers to PhDs

Postgraduate studies in EaP countries are often paid for their own citizens. There is no obligatory payment of fees for doctoral students. These circumstances also do not contribute to improving the quality of PhD. After all, it is assumed that a graduate student is a capable, motivated researcher who is ready to work actively during the training period for a very low fee. The state and the training institution should be interested in such workers.

Figures 9 and 10 demonstrate the incorrectness of using the indicator “number of PhDs per thousand inhabitants” for the purpose of comparing R&D and education systems in different countries. This indicator should be treated with caution, since the quality of dissertations (theses) differs from country to country.

*3.6. Gender composition of researchers*

The gender balance in the R&D systems of the EaP countries measured using surname-based sampling is quite consistent with that characteristic of the former socialist countries that became members of the EU (Fig. 11). It practically coincides with official statistical data published by UNESCO (data.uis.unesco.org). In this regard, EaP countries have no problems.

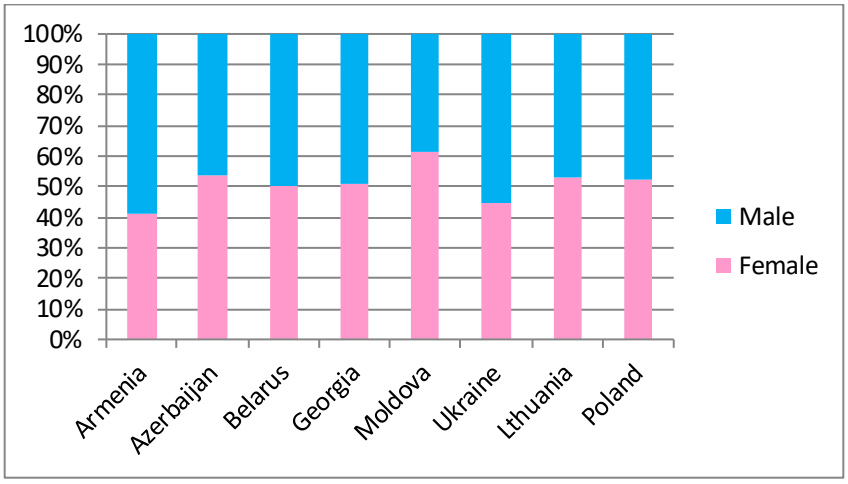



Figure 11. Gender balance of researchers

*3.7. Scientific Diasporas of EaP countries*

Scientific diasporas are fairly regarded in developing countries, including in EaP countries, as one of the resources for development (Tejada, G., Varzari, V., & Porcescu, S., 2013). The transformation of the former Soviet republics into independent states immediately led to the birth of diasporas in them at the expense of people who lived on the territory of the USSR outside the borders of the former union republics - now new independent states. Part of the population which had formed diasporas was engaged in research and formed scientific diasporas. However, today the size and distribution of scientific diasporas does not correlate with the distribution and size of general diasporas.

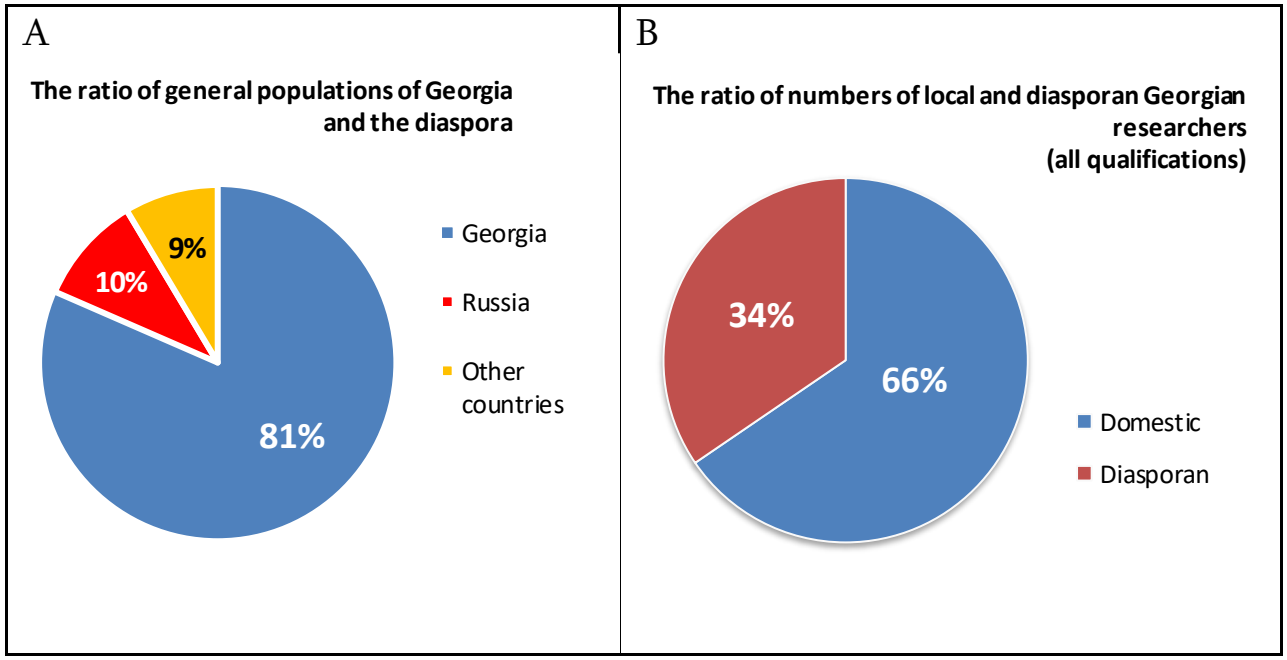
For example, according to the Pew Research Center, in 2017, 840,000 people of Georgian origin lived in other countries, including 450,000 in Russia[13]. This gives the ratio of residents of Georgia and the diaspora shown in Fig. 12A, according to which 81% of people of Georgian origin live in Georgia. However, only 66% of researchers of Georgian origin live in Georgia, i.e. the intensity of migration of scientists is higher than the general migration. The conclusion is obvious - there is a brain drain mechanism operating and, at the same time, the higher the qualifications, the higher the migration. Figures 12C and 12D show that HQR migration does not correlate neither with general migration of population, nor with researchers' migration in general. The demand for HQR is great, so they are freer to choose the country of destination and settle where conditions are better.

[13] www.pewresearch.org/global/interactives/global-migrant-stocks-map

Annex 4 provides similar data for all EaP countries, as well as for Lithuania and Poland (the latter is a good example for Ukraine). Data vary from EaP country to country, but some general patterns can be seen. The USA absorbs more HQRs from the EaP countries than the EU countries combined. This is surprising because the EU is closer, the EU has more students from EaP countries, and EaP countries have a closer relationship with the EU. There seems to be a need for a dedicated policy within the EaP initiative so as not to lose the best of the best.

In the scientific diasporas of all EaP countries, the share of HQR is higher than in national systems, and the average age is lower by about 15-20 years. We calculated the number of HQRs in the diaspora communities of Armenia and Georgia and received 1400 and 600 people, respectively. For small R&D systems with 3-4 thousand R&D employees, these are significant numbers. Interaction with them can significantly enrich national systems, provided an appropriate policies and mechanisms of interaction with diasporas are developed.

We also have assessed using the minimum number of HQR who emigrated from EaP countries (assuming that their number equals to a number of HQR from EaP countries living currently abroad, which is very approximate). The number we obtained is 9 thousand. There are publications estimating cost of an HQR training as USD 1 million[14]. This way EaP countries have 'gifted' to the hosting countries not less than USD 9 billion, but with their lifelong contribution to hosting countries' welfare, - much more.




[14] http://www.ras.ru/digest/showdnews.aspx?id=8a8ae666-96f9-440c-a68e-989928c35eab

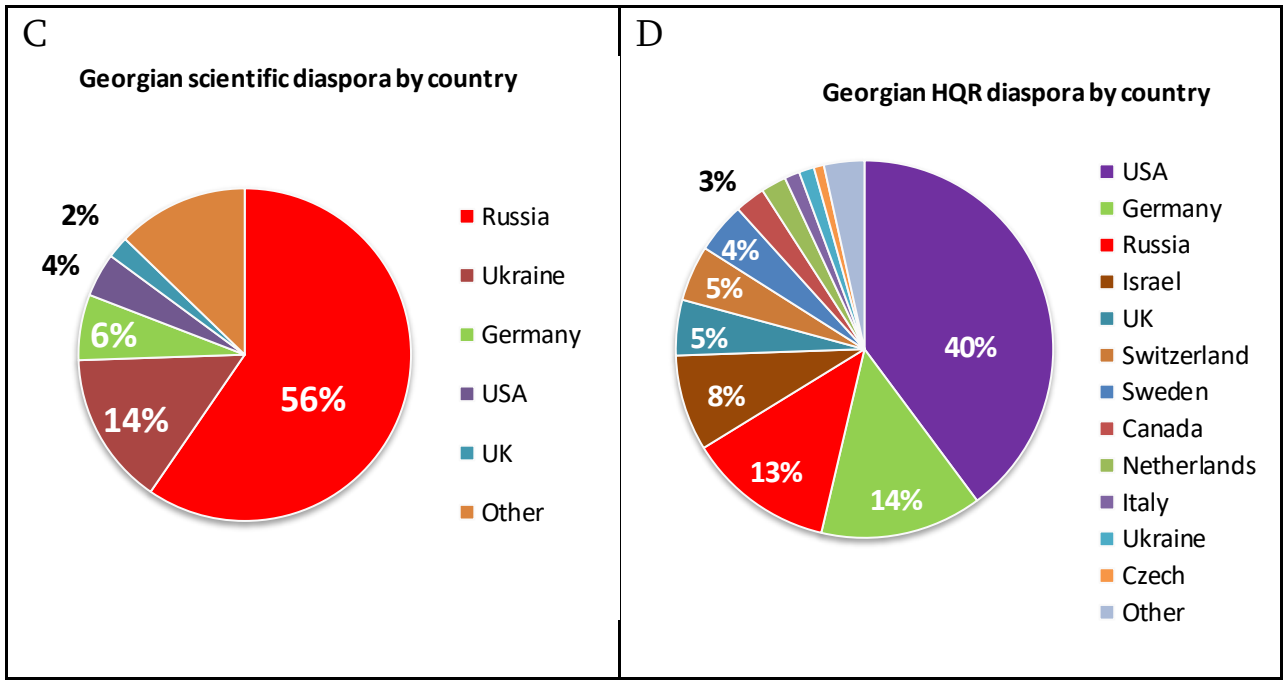



Fig. 12. Correlation of distributions of the general diaspora, the diasporas of all scientists and of HQRs

*3.8. Quality of R&D systems' managers*

The PSF mission in Georgia made comments on the low level of R&D management at the university level (European Commission, 2018, p. 27). We assessed this circumstance in other EaP countries by checking if the rectors of the leading universities meet the HQR criterion. It turned out that most of them do not. The higher level of agencies, ministries, and parliaments can be judged by the quality of the regulations discussed in Chapter 2. One of the obstacles to remedying the situation is the high rotation of top management personnel. In the Box 7 examples of science and education ministers' rotation are given.

Box 7

**Rotation of top R&D managers in EaP countries (examples)**

In **Armenia** in 18 years 9 ministers of science and education have been changed (http://escs.am/ru/static/history)

In **Georgia**, 16 ministers of science and education have been changed in the last 16 years, and even more deputy ministers responsible for research. (https://www.mes.gov.ge/content.php?id=110&lang=geo)

In **Moldova** 9 ministers of education, culture and research have been changed in the last 10 years (https://ru.wikipedia.org/wiki/Министерство_образования,_культуры_и_исследований_Республики_Молдова#Источники)

In **Ukraine** 7 ministers of education and science have been changed in the last 10 years.

*3.9. Conclusions from Chapter 3.*

The problems common to EaP countries, presented in Chapters 1 and 2, have led to problems with human capital. These are the most difficult and slow-to-fix problems that require attention

from both the governments of EaP countries and from the EU in the framework of the EaP Initiative. Without their consistent solution, the declared integration into ERA cannot be carried out successfully. But there are even more risks. If fading of research systems will continue, the drop done of educational systems' quality will be further stimulated. As it is a feedback process, the negative consequences of it in the field of R&D human capital will deepen, affecting, primarily through education, all aspects of EaP countries' life.

Based on this, we formulate, first of all, recommendations not of a technical, but of a political nature:

- Recognize that the current state and trends related to human resources (human capital) in R&D and education pose a threat to the successful development and stability of the EaP countries.
- Raise up the importance of the R&D and education systems' development in the framework of the EaP Initiative to the level of problems related to human rights, democracy and justice.
- Revise plans and roadmaps in the field of R&D and education derived from Association Agreements with the associated countries, as well as from agreements with non-associated countries participating in the EaP Initiative.
- Strengthen, following the example of human rights, democracy and justice, advice to EaP governments on R&D and education.
- Strengthen, as in the areas of human rights, democracy and justice, monitoring of the state of affairs and the implementation of recommendations in R&D and education spheres.

In parallel, a number of technical issues should not be ignored, as to:

- Formulate clear requirements for individuals appointed / elected to leadership positions in R&D and higher education systems.
- Organize science management training for managers.
- HEI to adopt and implement The European Charter & Code for Researchers[15]
- Formulate principles for reform of the process of PhD studies, aimed at:
  - Increase requirements for applicants for doctorate (postgraduate) study
  - Involve them better to the research process ongoing in hosting organization
  - View doctoral students as capable, motivated researchers willing to work for a modest salary, and not as a source of income for the organizations in which they work (we consider the term "study" inappropriate).
  - Prolong doctoral study time.
- Study the reasons for the concentration of HQRs from EaP countries in the USA and not in the EU.
- Develop a policy framework for EaP countries on interaction with scientific diasporas, defining also the possible role of the EU in such policy.

[15] https://euraxess.ec.europa.eu/euraxess/charter-code-researchers

- Organize a permanent advisory service on national R&D policies and R&D systems management for EaP countries.
- Organize a permanent monitoring of implementation of plans and roadmaps adopted within EaP Initiative in R&D sphere.
- Analyze the past experience of international collaboration of EaP countries in R&D sphere and find ways of further enhancing it.

## Chapter 4
## Conclusions and recommendations aimed at improving the R&D policy within the framework of the EaP Initiative

The PSF missions in 2015-2018 have articulated the shortcomings of the national R&D systems of EaP countries in a concentrated and dramatic manner. But even earlier, within the framework of a number of international projects aimed at strengthening RDI systems, the governments of the EaP countries received information about the unsatisfactory state of these systems (e.g. IncoNet Armenia, 2015; IncoNet Georgia, 2015; WB, 2017). However, there is no positive reaction. R&D funding (GERD) has been at a very low level for many years and has shown zero or negative growth.

**In the EaP countries, including the countries that signed the Association Agreements, an atmosphere of many years' continuous disregard to the development of national R&D systems has been established, which has put them in danger of complete collapse, entailing the collapse of education systems, already quite weakened compared to the period of USSR.**

The research systems of the EaP countries in their current state are not able to influence not only economic development, but even the training of highly qualified personnel for the education system. EaP countries are gradually losing human capital. This means that even with the full mobilization of available resources, through the non-research innovation and copying best practices, at best, they will be able within 10-12 years to grow economically from USD 3-7 thousand GDP per capita up to USD 8-12 thousand USD GDP per capita, after which there will again come a long stagnation and, accordingly, political instability. Such a prospect cannot please either the population of the EaP countries, or the EU, on the borders of which events will be unleashed.

The shortcomings of R&D governance in EaP countries, along with the scarce funding of R&D systems, are caused by the poor quality of laws governing the operation of R&D systems. Ukraine has made progress in this direction, although the requirements of the law are often not met in this country. The rest of the countries still have a lot to do. Poor quality means the following:

1. In most of EaP countries, the laws have serious gaps and do not cover the minimum range of issues required to govern the national R&D system.
2. The level of detailing of the laws' chapters is insufficient and does not correspond to that usual in the post-socialist EU members' laws.

3. Laws and also regulations concerning branch ministries and agencies do not facilitate their involvement in the management of the R&D sphere, thus excluding cross-sectoral cooperation and coordination.
4. Laws do not describe clearly the R&D management system at the national level, as well as the distribution of duties and responsibilities in it.

**Legislators in EaP countries require significant methodological assistance in developing laws and regulations related to R&D and their implementation, ex ante and ex post impact assessment.**

Funding and management problems have also created problems with human capital in all 6 countries, namely:

1. Severe reduction in the number of R&D employees.
2. An increase in the average age of R&D employees, as a result of the lack of an influx of young people, as well as an outflow of relatively young qualified scientists.
3. Especially sharp aging of highly qualified researchers and the same sharp decline in their number, leading to a shortage of research leaders.
4. Decline in the average quality of awarded academic degrees.

**The human capital problems are the most slowly corrected problems that require timely attention from both the governments of the EaP countries and the EU within the EaP Initiative. Without their consistent solution, the declared integration into ERA cannot be carried out successfully. The degradation of research systems will continue, stimulating the degradation of educational systems. The negative consequences of the observed process in the field of human capital R&D will deepen, affecting, primarily through education, all aspects of life in the EaP countries**.

In the field of R&D and the closely related field of education, the speed of system rehabilitation is limited by the ability of people to assimilate knowledge, i.e. in principle, it cannot be as high as in the spheres of the economy, where investments can give quick results.

**Special (emergency) measures are needed to promptly turn the tide in the course of events in order to prevent a dangerous situation that will delay the development of these countries for at least 20 years and will generate political crises on the eastern borders of the EU.**

The similarity of the indicators of the national R&D systems of the EaP countries, as well as the similarity of the motives and actions of their governments, which led to the low indicators, point out at the possibility of developing such measures for the entire region. However, a change in the existing multi-year picture will be possible only if all countries take the appropriate political decisions, and will be supported by the EU.

Based on this, we formulate, first of all, recommendations not of a technical, but of a political nature.

**Recommendation 1.**

Taking into account the fact that education belongs to the category of fundamental human rights, as well as the fact that the modern education system cannot exist without a research system, raise the importance of the development of R&D and education systems within the framework of the EaP Initiative to the level of problems related to human rights, democracy and justice.

**Recommendation 2.**
To devote a special EaP Summit to development of the human capital, at which it will be recognized that the current state of R&D and education systems pose a threat to the successful development and stability of EaP countries.

**Recommendation 3.**
To take a decision at the summit:

- To revise plans and roadmaps in the field of R&D and education arising from Association Agreements with associated countries, as well as from agreements with non-associated countries participating in the EaP Initiative.
- To fund Policy Support Facility follow-up mission that will analyze the situation in all EaP countries, including the level of implementing the recommendations made during the previous PSF missions.
- To elaborate policy briefs with recommendations on topics that are common for all EaP countries.
- To apply really 'more for more' principle.

**Recommendation 4.**
Strengthen, following the example of the areas of human rights, democracy and justice, monitoring of the state of affairs and the implementation of recommendations in the field of R&D and education, using the EaP Civil Society Forum platform.

**Recommendation 5.**
Strengthen, following the example of the areas of human rights, democracy and justice, advice to the governments of the EaP countries in the field of national R&D policy and the management of R&D systems by organizing a 3-year project coordinated by European organizations. It can be a project within Horizon Europe, or a project like *The Support Group for Ukraine (SGUA)* (https://ec.europa.eu/neighborhood-enlargement/neighbourhood/countries/ukraine/sgua_en).

**Recommendation 6.**
In the framework of monitoring (Recommendation 4) and consulting/advising (Recommendation 5) projects, explore and resolve a number of research and technical issues:

- Study the reasons for the concentration of HQR from EaP countries in the USA, not in the EU.
- Develop for EaP countries a policy framework for engaging with scientific diasporas, defining in it also the possible role of the EU.
- Develop minimum requirements for national information systems on R&D activities in the country.

- To encourage EaP research institutions / HEI to adopt and implement The European Charter & Code for Researchers (https://euraxess.ec.europa.eu/euraxess/charter-code-researchers).
- Formulate clear formal requirements for persons appointed / elected to leadership positions in R&D and higher education, as well as for appointment / election procedures.
- To introduce continuous training for researchers, to organize science management training for managers.
- Develop recommendations for the reform of the process of PhD studies, with a view to increasing the requirement for admission to post-graduate study, and considering post-graduate students as capable, motivated researchers willing to work for a modest salary, but not as a source of income for the organizations in which they work. Revising the timing of post-graduate study is also necessary.

**These recommendations together with recommendations by PSF missions to Armenia, Georgia, Moldova and Ukraine form a solid base for the further improvement of RDI policies within EaP Initiative.**

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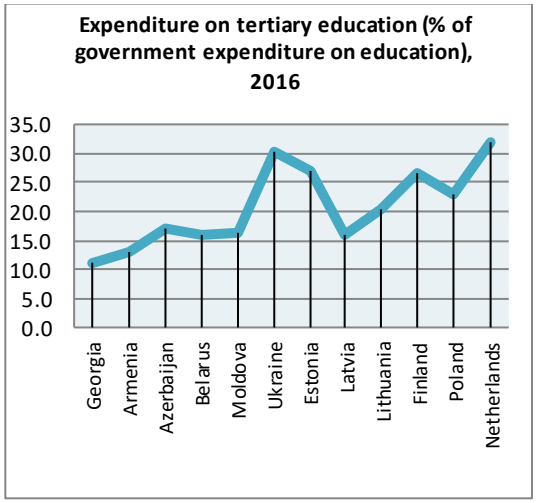
## Annex 1. R&D systems' characteristics in EaP and selected EU countries

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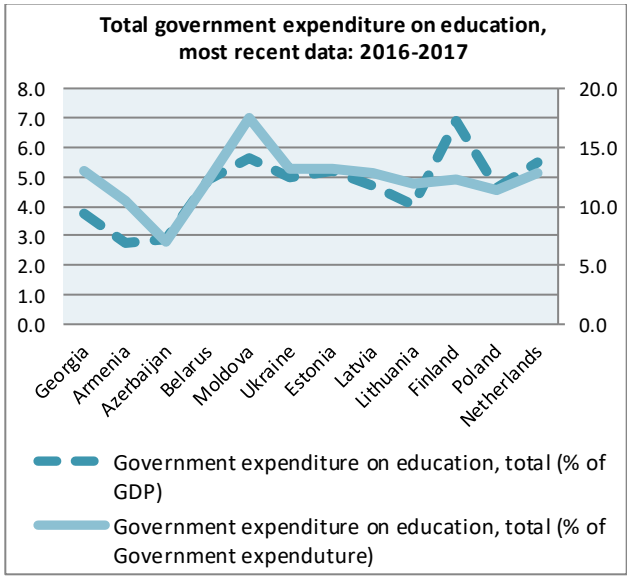
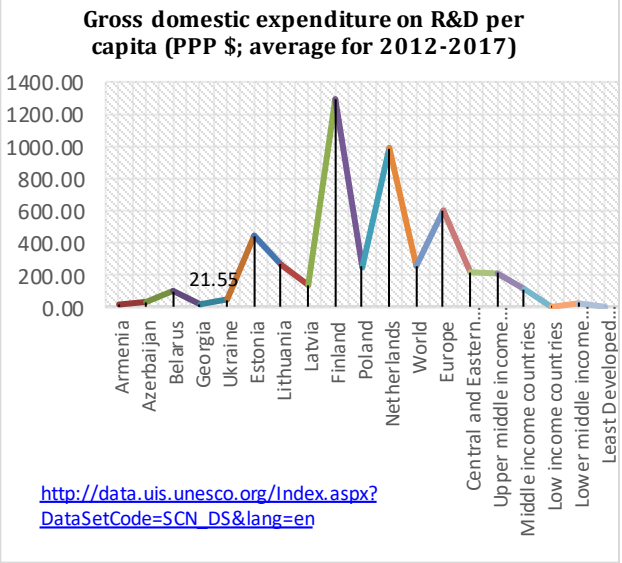
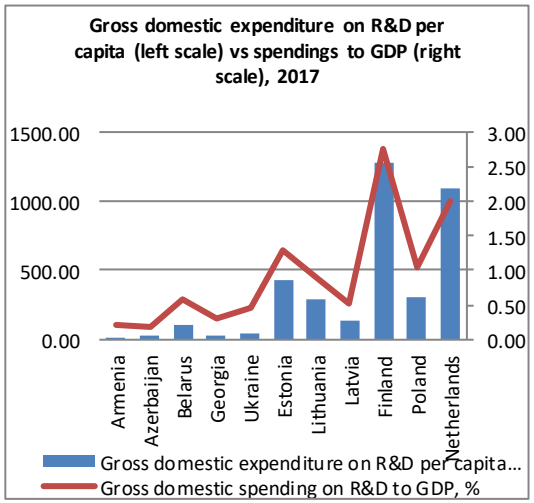
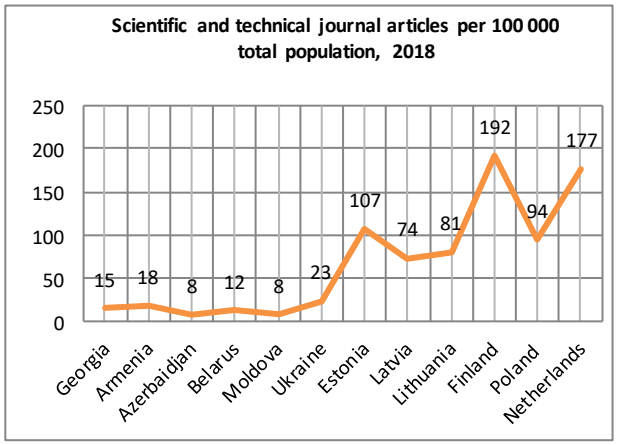


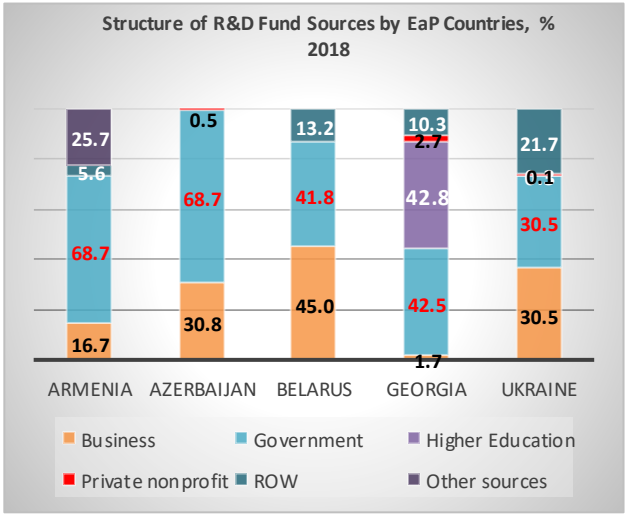



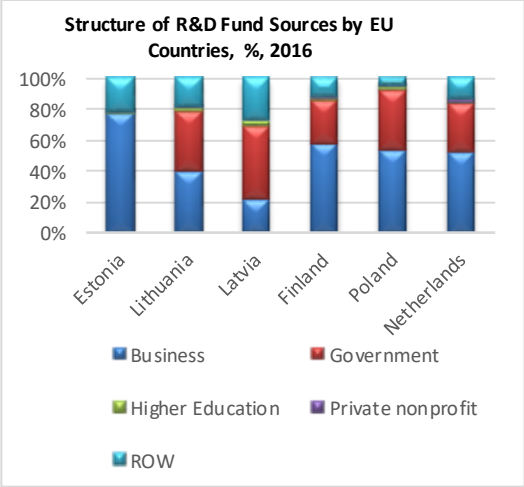

http://data.uis.unesco.org/Index.aspx?DataSetCode=SCN_DS&lang=en

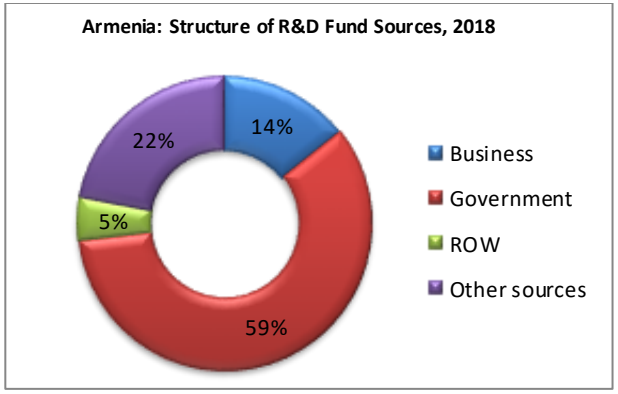


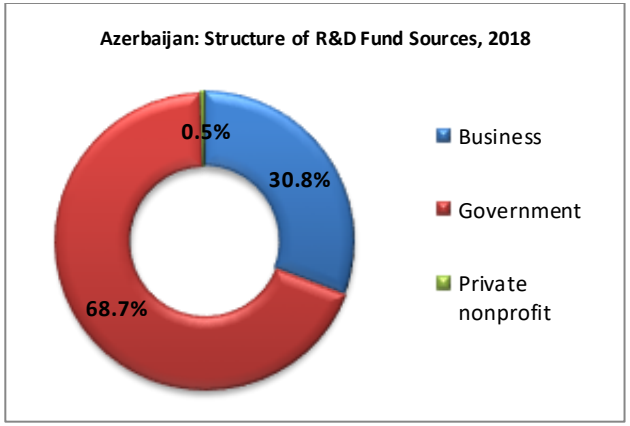



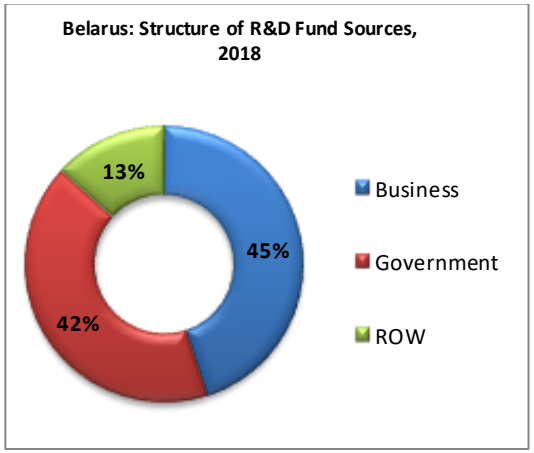

https://knoema.com/atlas/Georgia/topics/Research-and-Development/RandD-Expenditure/Scientific-and-technical-journal-articles

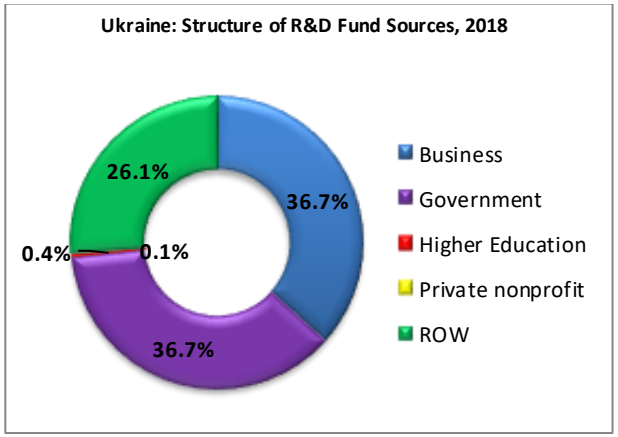


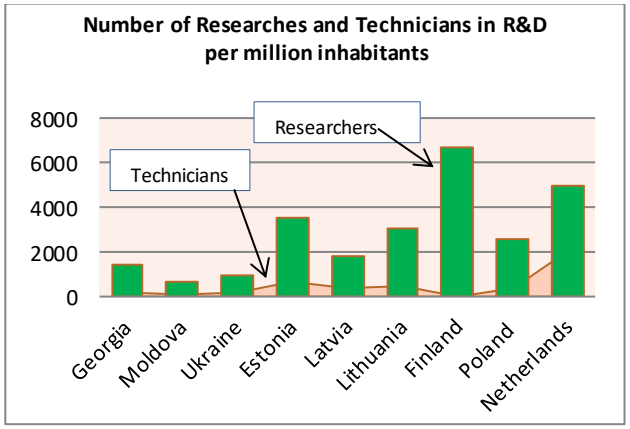

Structure of R&D Fund Sources by EU Countries, %, 2016
100%
80%
60%
40%
20%
0%
Estonia
Lithuania
Latvia
Finland
Poland
Netherlands
Business
Government
Higher Education
Private nonprofit
ROW


Armenia: Structure of R&D Fund Sources, 2018
14%
59%
5%
22%
Business
Government
ROW
Other sources


Azerbaijan: Structure of R&D Fund Sources, 2018
0.5%
30.8%
68.7%
Business
Government
Private nonprofit


Belarus: Structure of R&D Fund Sources, 2018
13%
45%
42%
Business
Government
ROW


Ukraine: Structure of R&D Fund Sources, 2018
26.1%
36.7%
0.4%
0.1%
36.7%
Business
Government
Higher Education
Private nonprofit
ROW


Number of Researches and Technicians in R&D per million inhabitants
8000
6000
4000
2000
0
Researchers
Technicians
Georgia
Moldova
Ukraine
Estonia
Latvia
Lithuania
Finland
Poland
Netherlands

## Annex 2. Content analyses of laws on scientific activities

Designation: the white cells indicate absence of the rubric in the law

| | Rubric | Ukraine | Belarus | Moldova | Georgia | Armenia | Azerbaijan |
|---|---|---|---|---|---|---|---|
| | | Law of UKRAINE On Scientific and Scientific and Technology Activities 26.11.2015 № 848-VIII | Law of Belarus On Scientific Activities 21.10.1996 | The Code about Science and Innovation of July 15, 2004 No. 259-XV | Law of Georgia No 2469 of 23 December 2005 on Science, Technology and their Development | Law On Scientific and Scientific and Technology Activities 5.12.2000 | Law On Science Of the Republic of Azerbaijan 14.06.2016 |
| 1 | Definitions of terms | | | | | | |
| 2 | The main tasks of the law | | | | | | |
| 3 | Participants of scientific and scientific-technical activity | | | | | | |
| 4 | Scientist - definition | | | | | | |
| 5 | Scientific employee - definition | | | | | | |
| 6 | Scientific institution - definition | | | | | | |
| 7 | Certification of scientific institutions | | | | | | |
| 8 | State register of scientific institutions to which state support is provided | | | | | | |
| 9 | Research infrastructure other than research institutions | | | | | | |
| 10 | Role of National Academy of Sciences | | | | | | |
| 11 | Existance of National branch academies of sciences | | | | | | |
| 12 | Scientific activity in the system of higher education | | | | | | |
| 13 | National Council for Science and Technology Development | | | | | | |
| 14 | Scientific NGOs | | | | | | |
| 15 | The Council of Young Scientists | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 16 | Regional research centers | | | | | | |
| 17 | Involvement of school children in Scientific and technical activities | | | | | | |
| 18 | Training of scientific personnel | | | | | | |
| 19 | Scientific degrees and academic ranks | | | | | | |
| 20 | Qualification assessment | | | | | | |
| 21 | Positions of scientific workers | | | | | | |
| 22 | Scientific internship | | | | | | |
| 23 | Salaries of scientists | | | | | | |
| 24 | Social protection of a researcher | | | | | | |
| 25 | State control over the activities of the Academy of Science | | | | | | |
| 26 | Obligations of the State | | | | | | |
| 27 | Powers of Parlament | | | | | | |
| 28 | Powers of the Cabinet of Ministers | | | | | | |
| 29 | Central executive body in the field of scientific activities | | | | | | |
| 30 | Powers of other central executive bodies | | | | | | |
| 31 | Powers of local executive bodies | | | | | | |
| 32 | The purposes and directions of the state policy | | | | | | |
| 33 | Basic principles of public administration and regulation | | | | | | |
| 34 | Financial and credit and tax instruments of state regulation | | | | | | |
| 35 | Financial support of scientific activity | | | | | | |
| 36 | National Research Fund | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 37 | Implementation of state scientific and technological programmes | | | | | | |
| 38 | Competitive selection of R&D projects | | | | | | |
| 39 | Grant support of scientific activity | | | | | | |
| 40 | Participation of the state research institutions in creation of business companies | | | | | | |
| 41 | Ensuring the development of human resources | | | | | | |
| 42 | Scientific and technical expertise | | | | | | |
| 43 | System of scientific and technical information | | | | | | |
| 44 | Acquisition, protection and defense of intellectual property rights | | | | | | |
| 45 | State support of international scientific cooperation | | | | | | |
| 46 | State support for innovation activities | | | | | | |

## Annex 3. Reflection of R&D activities in ministries' statutes in EaP countries

Designations in the table:

Green - functions in R&D sphere are clearly defined in the statute

Yellow - functions in R&D sphere are just mentioned in the statute

Red - R&D activities are not mentioned in the statute

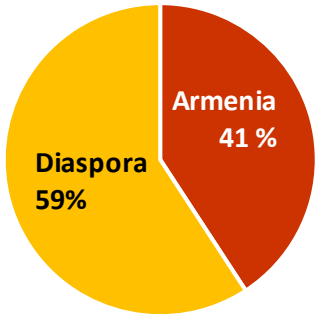
"-" – indicates absence of a ministry

| # | Ukraine | | Belarus | | Moldova | | Georgia | | Armenia | | Azerbaijan | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ministry name | **Mark** | Ministry name | **Mark** | Ministry name | **Mark** | Ministry name | **Mark** | Ministry name | **Mark** | Ministry name | **Mark** |
| 1 | Education and science | | Education | | Education, culture and research | | Education, Science, Culture and Sports | | Education, science, culture and sport | | Education | |
| 2 | Digital transformation | | Communications and Informatization | | - | | - | | - | | - | |
| 3 | Youth and Sport | | Sports and Tourism | | - | | - | | - | | Youth and Sports | |
| 4 | Culture and information policy | | Culture | | - | | - | | - | | Culture | |
| 5 | - | | Information | | - | | - | | - | | - | |
| 6 | Regional Development | | Housing and Communal Services | | - | | Regional Development and Infrastructure | | Territorial Administration and Infrastructures | | - | |
| 7 | Infrastructure | | Transport and Communications | | - | | - | | - | | Transport, Communications and High Technologies | |
| 8 | - | | Architecture and Construction | | - | | - | | - | | - | |
| 9 | Economic development, trade and agriculture | | Economy | | Economy and Infrastructure | | Economy and sustainable development | | Economy | | Economy | |
| 10 | - | | Antimonopoly Regulation and Trade | | - | | - | | - | | - | |
| 11 | Finance | | Finance | | Finance | | Finance | | Finance | | Finance | |

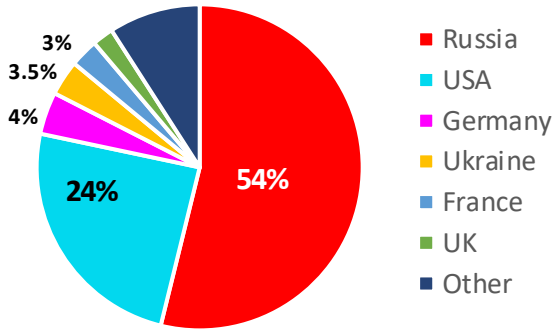
| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | - | | Taxes and Duties | | | | - | | - | | - | |
| 13 | Health | | Public Health | | Health, Labor and Social Protection | | Internally Displaced Persons from the Occupied Territories, Labour, Health and Social Affairs | | Health | | Health | |
| 14 | Internal Affairs | | Internal Affairs | | Internal Affairs | | Internal Affairs | | - | | Internal Affairs | |
| 15 | - | | Emergency Situations | | - | | - | | Emergency Situations | | Emergency Situations | |
| 16 | Justice | | Justice | | Justice | | Justice | | Justice | | Justice | |
| 17 | Foreign Affairs | | Foreign Affairs | | Foreign Affairs and European Integration | | Foreign Affairs | | Foreign Affairs | | Foreign Affairs | |
| 18 | Defence | | Defence | | Defence | | Defence | | Defence | | Defence | |
| 19 | Reintegration of Temporarily Occupied Territories | | - | | - | | - | | - | | Defense Industry | |
| 20 | Veterans Affairs | | - | | - | | - | | - | | - | |
| 21 | Social Policy | | Labor and Social Protection | | - | | Reconciliation and Civic Equality | | Labor and Social Affairs | | Labor and Social Protection of Population | |
| 22 | Energy | | Energy | | - | | - | | - | | Energy | |
| 23 | - | | Agriculture and Food | | Agriculture, Regional Development and Environment | | Environment Protection and Agriculture | | High-Tech Industry | | Agriculture | |
| 24 | Environmental Protection and Natural Resources | | Natural Resources and Environmental Protection | | - | | - | | Environment | | Ecology and Natural Resources | |
| 25 | - | | Forestry | | - | | - | | - | | - | |
| 26 | - | | Industry | | - | | - | | - | | - | |

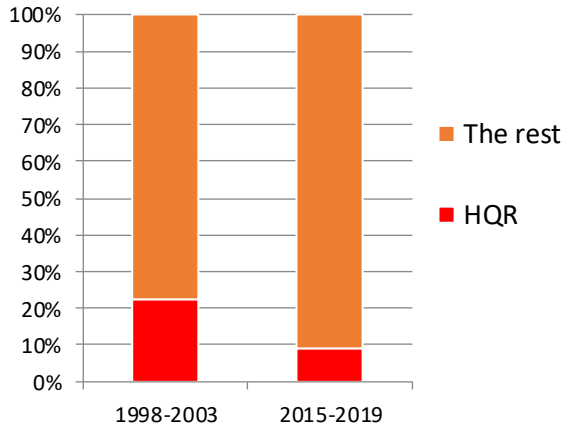
## Annex 4. Scientific diasporas and diasporas of HQRs[16] in EaP and selected post-socialist EU countries

**Armenia: local/diasporan researchers' balance**



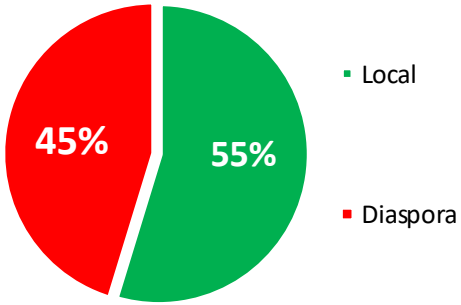

**Armenean scientific diaspora by country**



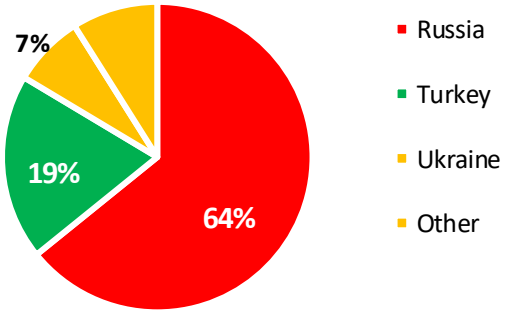



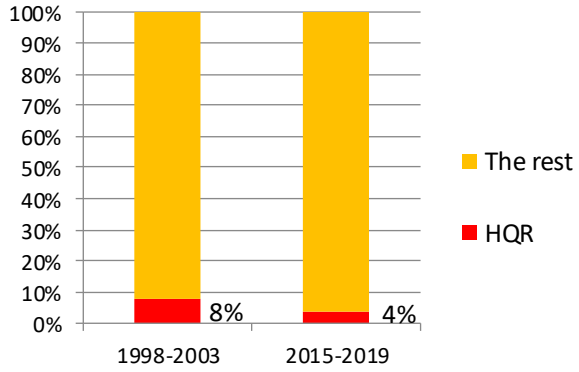

**Change of HQR share among local researchers in Armenia**

**Azerbaijan: local/diasporan researchers' balance**



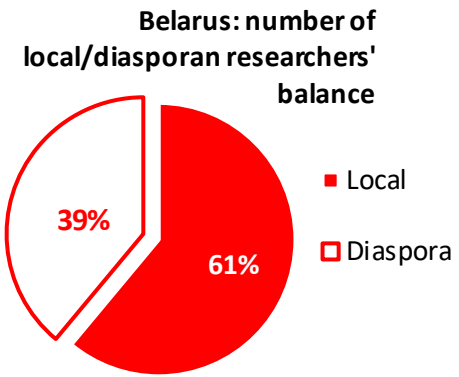

**Azerbaijanian scientific diaspora by country**

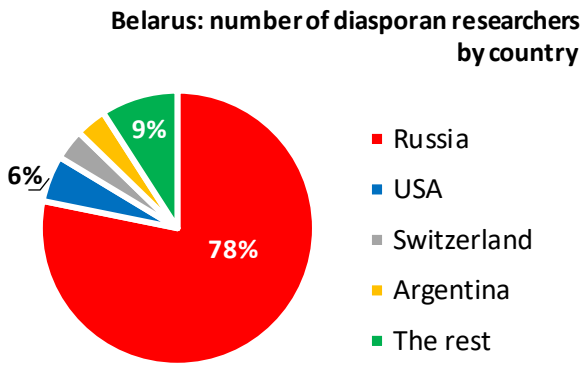


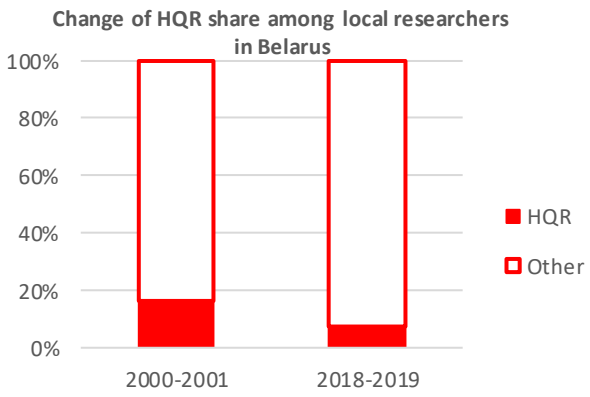



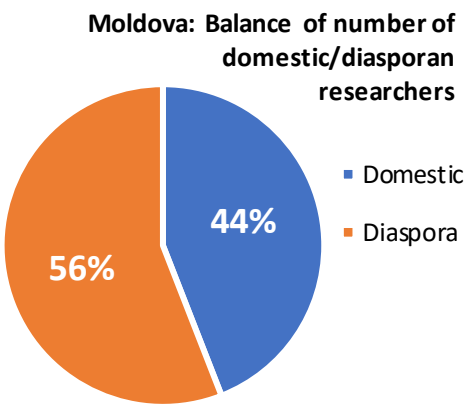

**Change of HQR share among local researchers in Azerbaijan**

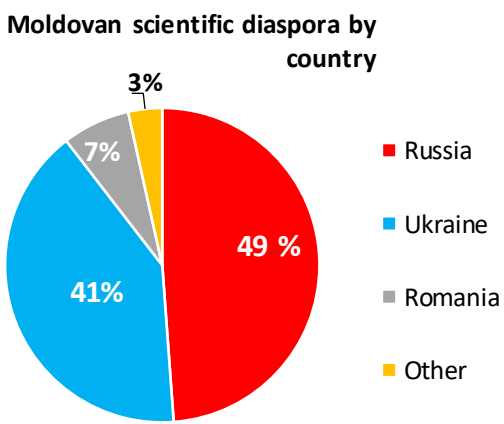
[16] HQR – Highly Qualified Researcher

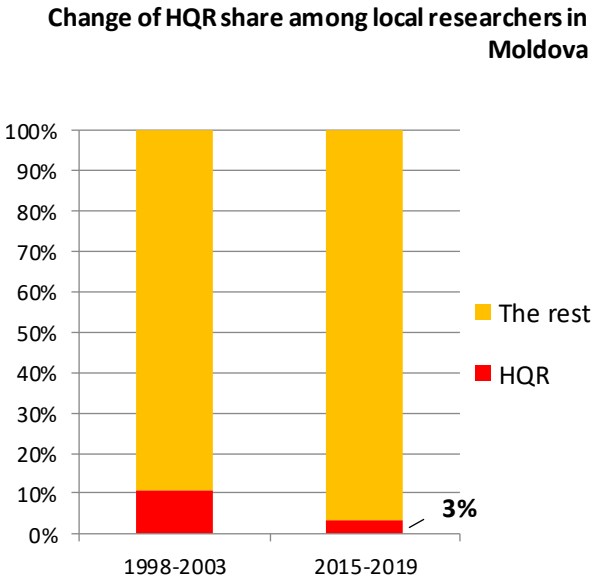

Belarus: number of local/diasporan researchers' balance
39%
61%
Local
Diaspora

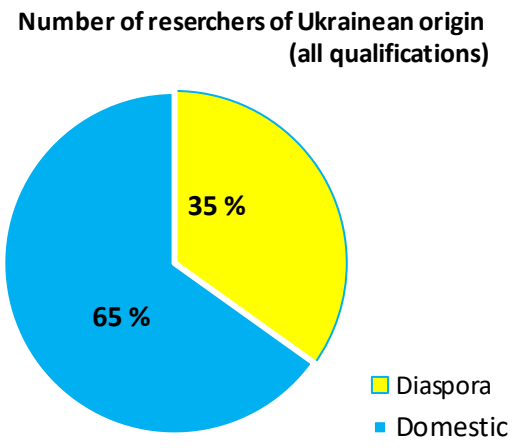

Belarus: number of diasporan researchers by country
9%
6%
78%
Russia
USA
Switzerland
Argentina
The rest

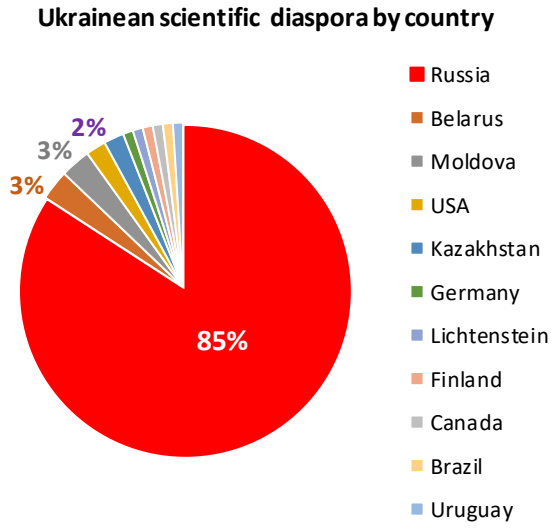

Change of HQR share among local researchers in Belarus
100%
80%
60%
40%
20%
0%
2000-2001
2018-2019
HQR
Other

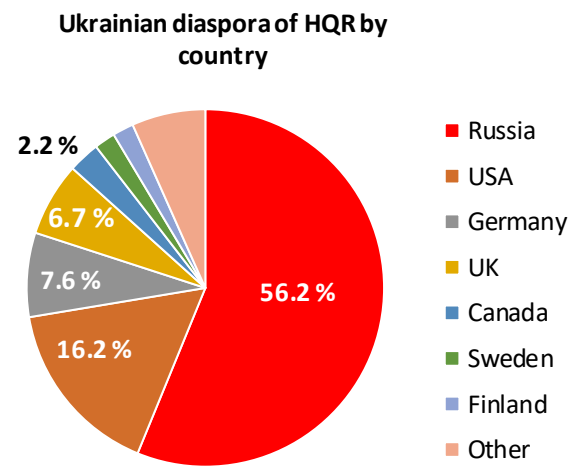

Moldova: Balance of number of domestic/diasporan researchers
44%
56%
Domestic
Diaspora

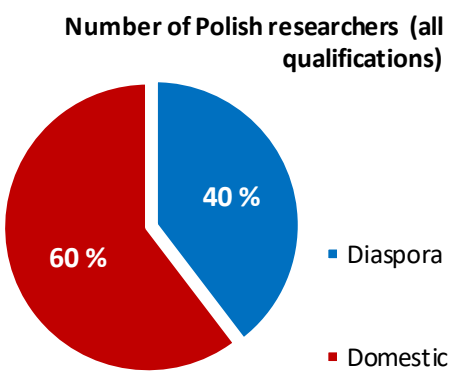

Moldovan scientific diaspora by country
3%
7%
49 %
41%
Russia
Ukraine
Romania
Other

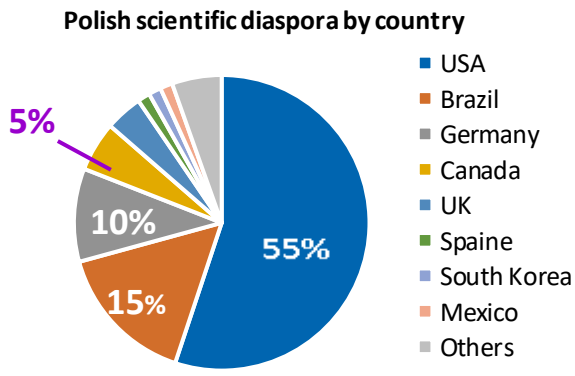

Change of HQR share among local researchers in Moldova
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
3%
1998-2003
2015-2019
The rest
HQR

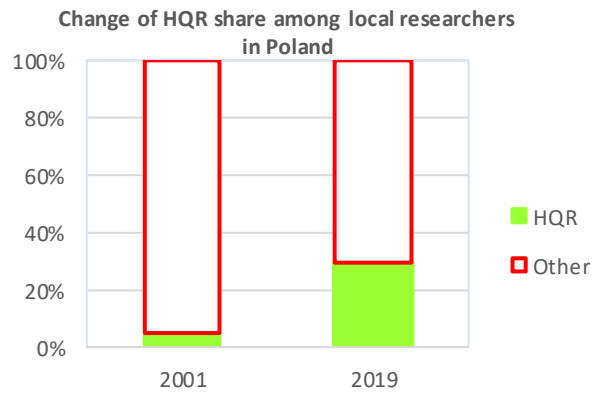

Number of reserchers of Ukrainean origin (all qualifications)
35 %
65 %
Diaspora
Domestic

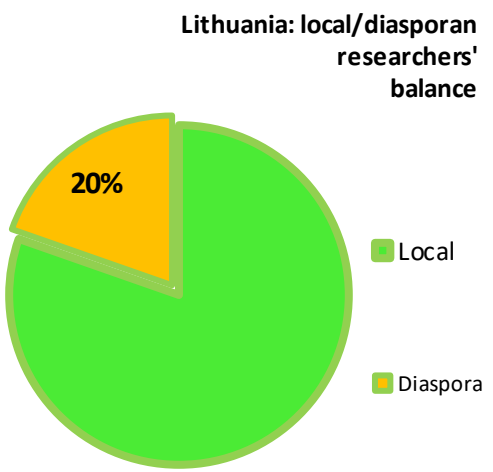

Ukrainean scientific diaspora by country
2%
3%
3%
85%
Russia
Belarus
Moldova
USA
Kazakhstan
Germany
Lichtenstein
Finland
Canada
Brazil
Uruguay

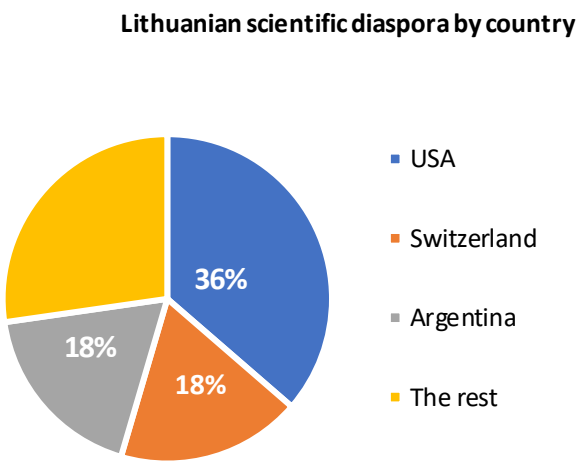

Ukrainian diaspora of HQR by country
2.2 %
6.7 %
7.6 %
16.2 %
56.2 %
Russia
USA
Germany
UK
Canada
Sweden
Finland
Other

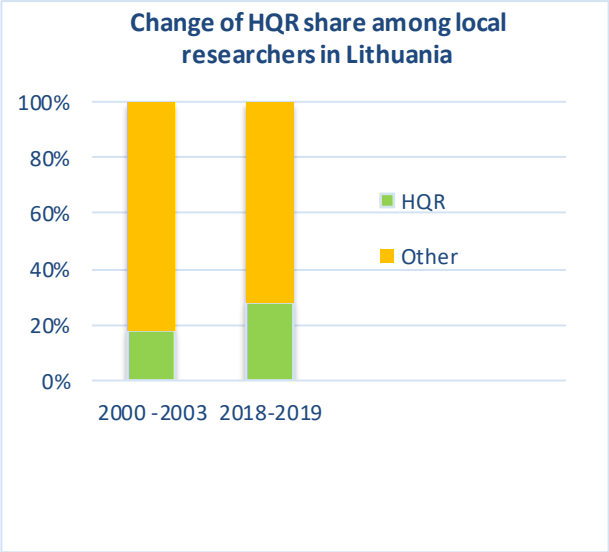

Number of Polish researchers (all qualifications)
40 %
60 %
Diaspora
Domestic


Polish scientific diaspora by country
5%
10%
15%
55%
USA
Brazil
Germany
Canada
UK
Spaine
South Korea
Mexico
Others


Change of HQR share among local researchers in Poland
100%
80%
60%
40%
20%
0%
2001
2019
HQR
Other


Lithuania: local/diasporan researchers' balance
20%
Local
Diaspora


Lithuanian scientific diaspora by country
36%
18%
18%
USA
Switzerland
Argentina
The rest


Change of HQR share among local researchers in Lithuania
100%
80%
60%
40%
20%
0%
2000 -2003
2018-2019
HQR
Other