# The future of science in Ukraine: Actions now will affect post-war recovery

4 November 2022

## Key messages

- "Brain drain" has been a long-standing challenge for science in Ukraine. Without global solidarity and policy actions to enable refugee scientists and diaspora to maintain strong links with their home institutions, the war with Russia is likely to accentuate the permanent loss of scientific expertise in Ukraine.
- Prior to Russia's large-scale aggression against Ukraine in 2022, the quality and international recognition of Ukrainian science had been steadily improving, although total R&D investment and the number of researchers had been decreasing.
- In recent years, Ukraine's international scientific collaboration and exchange had already begun to shift from Russia towards Western neighbouring countries, especially Poland, which is also the preferred destination for scholars fleeing the war.
- There is an opportunity now for OECD countries to build on the new and strengthened scientific relationships with Ukraine that are arising out of the war to relaunch science in Ukraine and support the country's recovery once the war is over.
- In the shorter term, it is essential that OECD countries continue to take action to host displaced scholars from Ukraine and support those who remain in the country. The Ukrainian diaspora can play an important role in facilitating this.

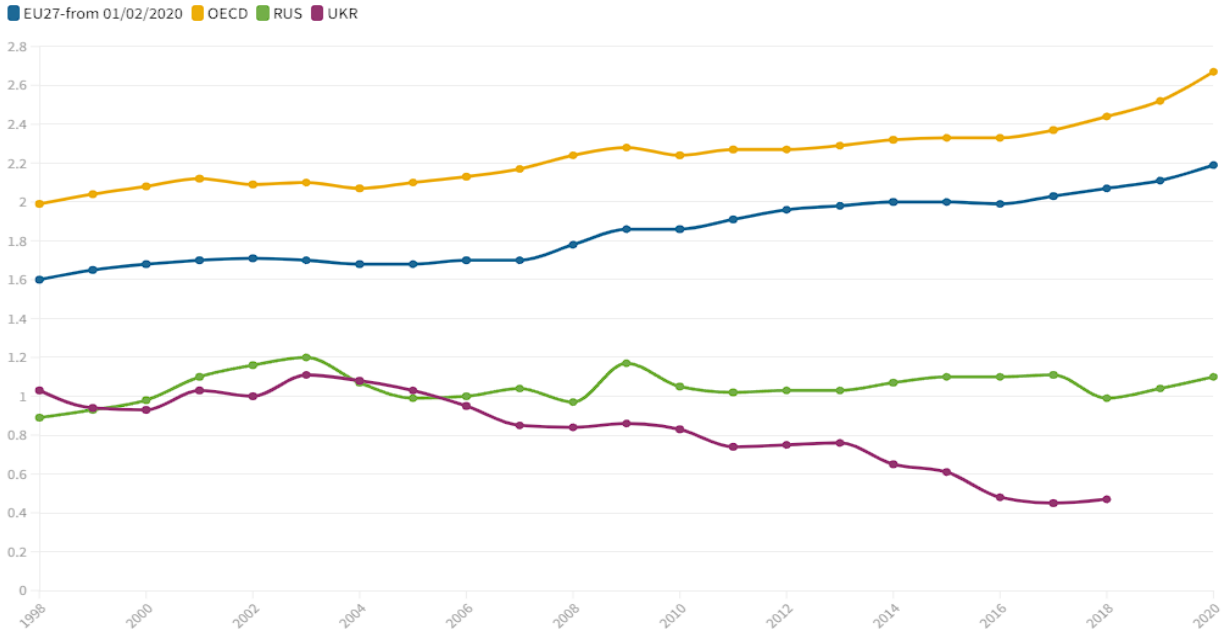


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## A science system with core strengths and in transition, shaken by the Russian aggression

For several years prior to the Russian aggression against Ukraine, science and research in Ukraine had been in transition, with significant structural changes taking place in the face of strong budgetary pressure. Domestic expenditure on research and development (R&D) as percentage of GDP fell by about one-third between 2013 and 2018 (Figure 1). The number of researchers shrunk from over 52 000 full time equivalents in 2013, to 41 000 in 2018. This evolution was marked by a steep fall in researchers in business and government institutions that was only partly offset by an increase of those in higher education (HE) institutions.

**Figure 1. Domestic R&D expenditure as percentage of GDP, 1998-2020**




Source: OECD Main Science and Technology Indicators and R&D statistics and UNESCO Institute of Statistics. Accessed from OECD STI.Scoreboard, July 2022. https://public.flourish.studio/visualisation/11296972/

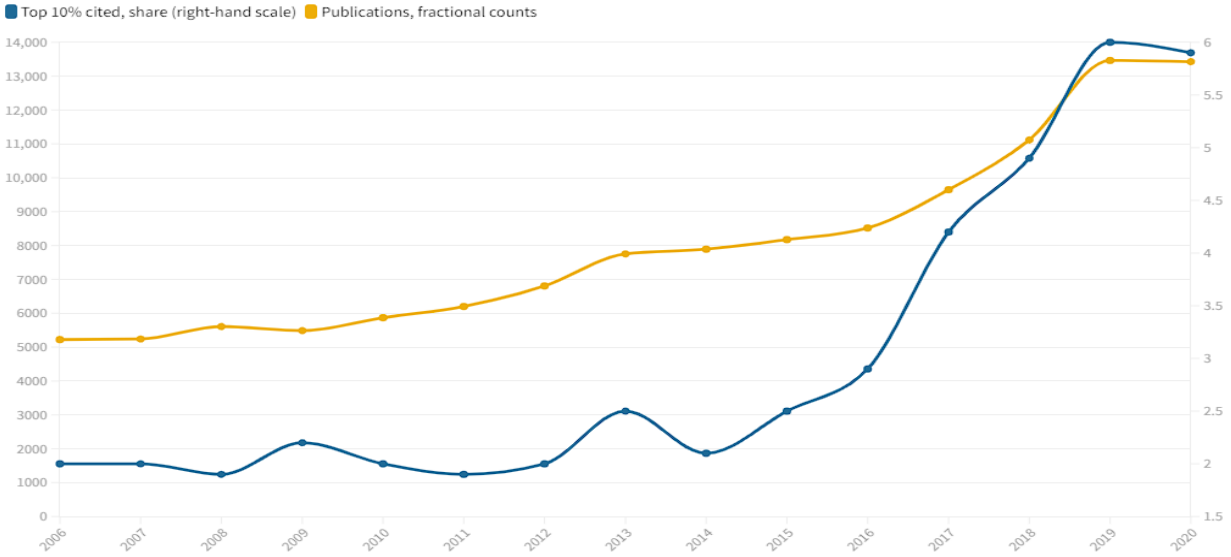
This reorientation towards HE, together with an increase in international collaborations, helps to explain an impressive rise in both the number and quality of scientific publications, from only 2% among the global top 10% most cited in their fields in 2006 to 6% in 2020 (Figure 2). Despite strong budgetary pressures and a decrease in the total number of researchers, the structural changes in the Ukrainian science system prior to the war had contributed to an increase in its scientific publication output and an improvement in average quality by international standards.



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**Figure 2. Quantity and quality of scientific production in Ukraine, 2006-2020**

Number of documents and percentage among world's 10% most cited publications, fractional counts




Source: OECD calculations based on Scopus Custom Data, Elsevier, Version 5.2021, September 2021. https://public.flourish.studio/visualisation/11289488/. Additional data at: https://public.flourish.studio/story/1266872/.

Ukrainian scientific output shows above average specialisation and expertise (proxied by citation impact) in areas such as Computer Science and Energy (Ukrainian nuclear engineers are involved in new nuclear build programmes around the world). Although less specialised, Ukrainian scientific output also excels in the areas of Earth and planetary sciences and Environmental science, while Engineering is the largest field in terms of total output (see interactive charts). All these domains are closely linked to Ukrainian industry and are crucial to economic development. As reported in the EU-OECD Science, Technology and Innovation Policy Compass (STIP Compass), Ukraine's main thematic STI policy strategies in 2021 focused on Aerospace and Artificial intelligence. It is also interesting to note that citations of Ukraine's scientific publications are twice as likely to come from scientific authors with affiliations in mainland China as from those in Russia or the United States, illustrating the worldwide recognition of its expertise in certain domains.

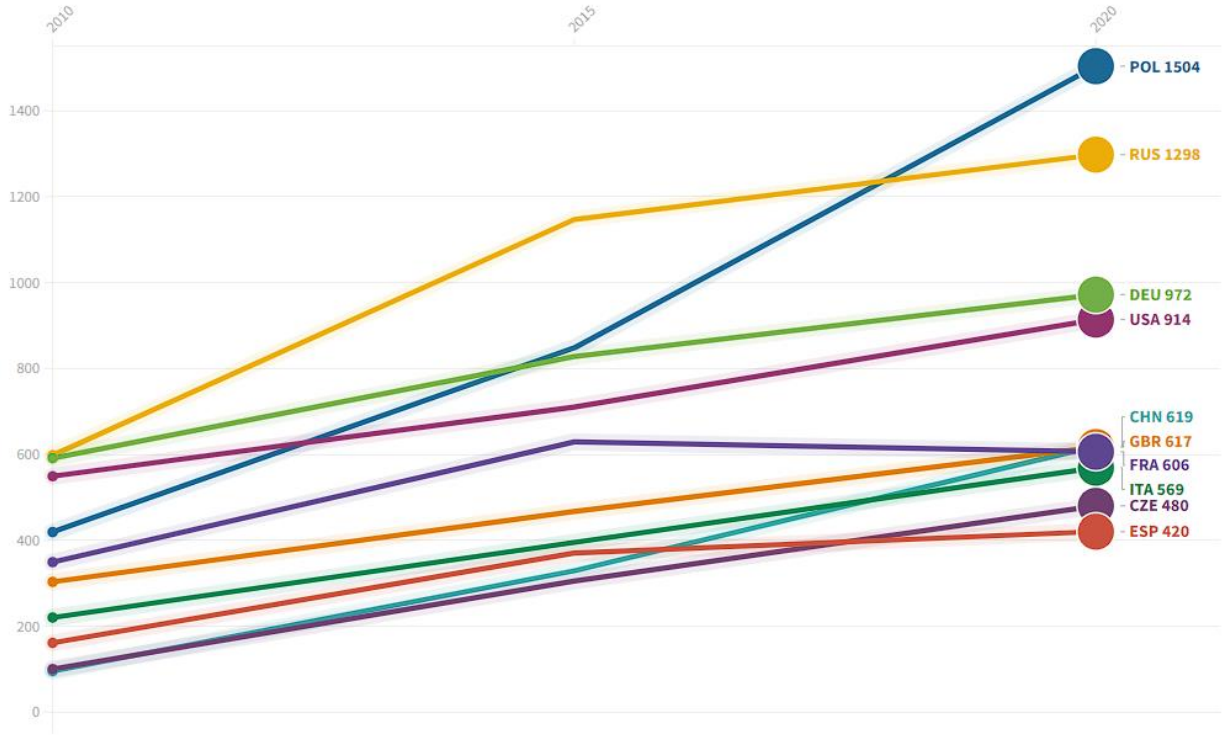
A significant proportion of Ukraine's scientific publication outputs have been the result of international collaborations and partnerships. Since 2013-14, Ukraine has managed to stop the progressive decline in international collaboration seen in previous years, which is likely to have played an important role in raising the overall competitiveness of its science. There has been a strategic focus on building international partnerships, as well as shifts in collaboration patterns. Russia-based scientists used to be the most frequent partners for Ukraine-based authors, while Polish-based scientists have emerged more recently as the preferred partners (Figure 3). This privileged relationship with Poland is also noticeable in the latest statistics on international students published by the OECD in *Education at a Glance*. These show that Poland is the largest recipient of Ukrainian tertiary international students, with nearly 27 000, followed by Russia with 21 000 and Germany with 6 000.



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**Figure 3. Ukraine's top scientific collaboration partners: 2010, 2015 and 2020**

Whole counts: Number of documents co-authored with partner country




Source: OECD calculations based on Scopus Custom Data, Elsevier, Version 5.2021, September 2021. Accessed from https://public.flourish.studio/visualisation/9410350/

## Supporting Ukrainian science and scientists during the war

One of the key structural problems hindering Ukrainian research and innovation activity prior to the war, as reported in the 2021 EC-OECD STIP Compass, was the persistent net outflow of talented scientists and inventors. There was an active debate on how to support these valuable human resources in the country and prevent "brain drain". Indeed, analysis of changes in affiliations of scientific authors over the 2010-20 period reveal that Ukraine had a bilateral deficit with most countries for which high mobility was observed, particularly with Russia (Figure 4). The war will certainly change the longer-term mobility patterns of many Ukrainian students and scientists, with long-lasting impacts.

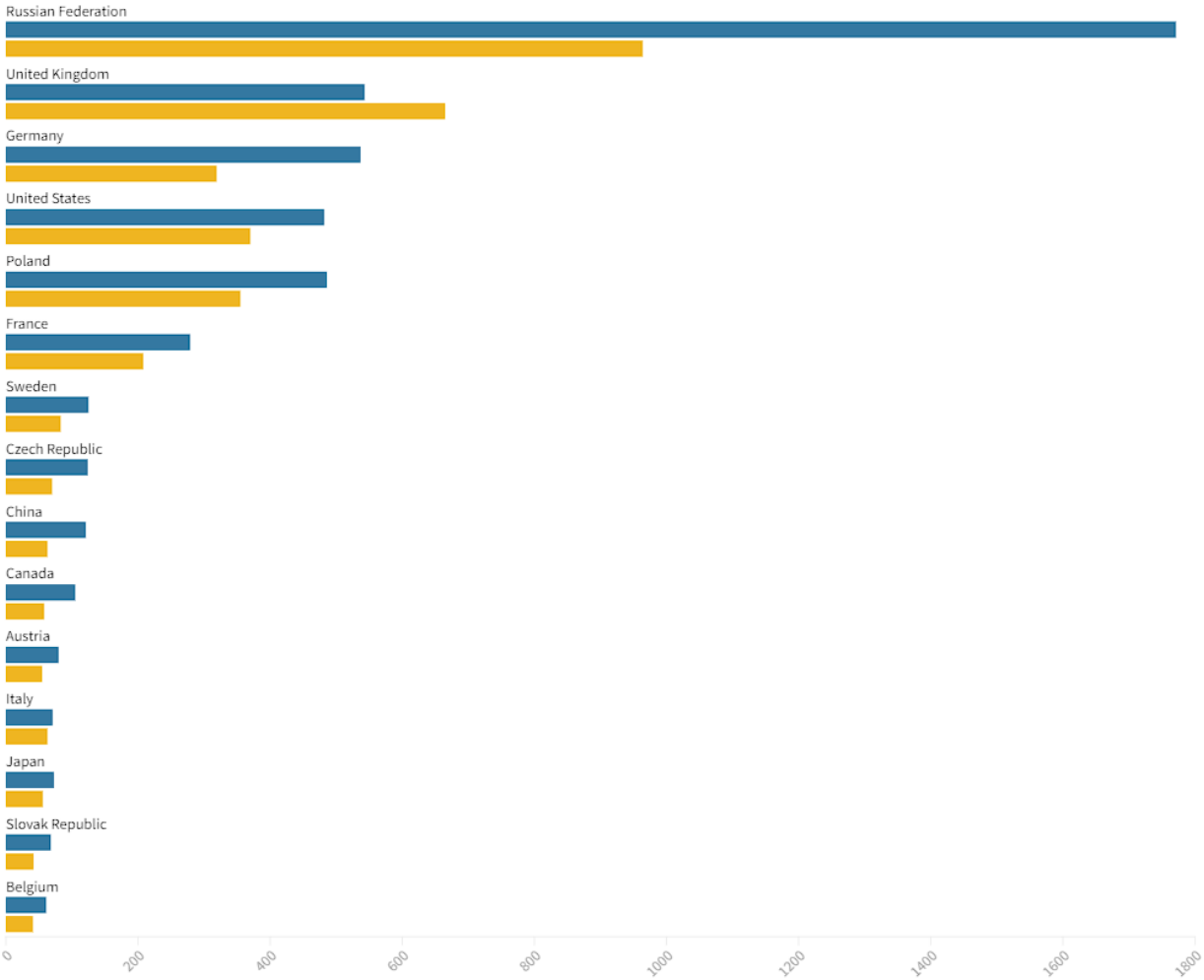
Previous OECD work has shown that measures of established scientific collaboration, as well as geographic and cultural proximity correlate positively with the observed flows of students and scientists between countries. Brain circulation is a complex and multi-directional phenomenon, where 'churn' is more significant than net gains or losses. These considerations are highly relevant for Ukraine. Brain circulation can be influenced by policies, such as those that lead to convergence in economic conditions and resources dedicated to R&D, as well as very practical measures such as reduced visa-related restrictions. In the context of Ukraine, this has both immediate and longer-term policy implications.



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**Figure 4. Bilateral flows of scientific authors from and to Ukraine, 2010-20**

Largest bilateral flows, by first and last recorded main affiliation




Source: OECD calculations based on Scopus Custom Data, Elsevier, Version 5.2021, September 2021. Accessed from https://public.flourish.studio/story/1502170/

With Russia's aggression, a large proportion of Ukrainian scientists have been forced or compelled to leave their current research positions. Among those who are eligible, many have joined the defence forces. Others have opted to move abroad as part of the six million documented departures from the country. Although accurate numbers are not easy to establish in the midst of war, the Young Scientist Council at Ukraine's Ministry of Science reported on 4th April that four to six thousand scholars had left Ukraine due to the invasion. Other more recent estimates put this number as high as 22 000 or around a quarter of the country's researchers. In light of this flight to safety, many countries and scientific institutions have put in place temporary measures to host Ukrainian students and researchers, providing safe havens in which they can continue their studies and conduct research.

For example, the European Commission's Horizon Europe programme recently made available EUR 25 million to support refugee Ukrainian scientists and address the immediate and urgent humanitarian challenge. The European Commission has also launched a one stop shop for information and support services to Ukraine-based researchers and researchers fleeing Ukraine. This European Research Area for Ukraine (ERA4Ukraine) portal brings together initiatives at the EU level, per country and from non-governmental groups. Solidarity is pervasive at the global level, as demonstrated by the inventory of offers



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of assistance and statements of support from science organisations that is being compiled by the International Science Council. For instance, the US National Academies of Science, in partnership with the Polish Academy of Sciences, launched an initiative to help Ukrainian researchers settle in neighbouring Poland.

## Planning for Ukraine's reconstruction with scientific talent at its core

The OECD Brief on Rights and Support for Ukrainian Refugees in Receiving Countries highlights a need for innovative "dual intent" solutions that ensure the skills of displaced Ukrainians are not left idle and continue to be built, while at the same time not hampering possible return to Ukraine once the war is over. However, there is a long history of scientists leaving their home countries during times of conflict or political crisis and then finding it very difficult to return or contribute effectively as diaspora once the crisis is over. In an ultra-competitive international science system where talent is at a premium, many of the best Ukrainian scientists or students may be tempted to stay in their new homes rather than return to institutions that have been subject to the ravages of war. At the individual level, this would be a very legitimate and understandable choice. But what can be done now to ensure that such individual choices do not severely cripple the longer-term future of Ukrainian science?

It is unlikely that the strong historical links between Russian and Ukrainian science can survive the devastation of war. Whilst collaborations between individual scientists can be very resilient, it will take a long time for trust between research institutions in these countries to be re-established. Poland on the other hand, which was already emerging as a preferred partner of choice for Ukrainian scientists (Figure 3), has been a particularly welcoming neighbour. Many refugee scientists and students have already been accepted into Polish research institutions. There is an opportunity to strengthen scientific partnerships between these two countries, with immediate benefits for Poland and longer-term possibilities for Ukraine. However, Poland will require support and solidarity from other countries and the European Union if it is to effectively perform this temporary hosting role. This includes support for those who choose to return to Ukraine to be able to do so and for new sustainable, long-term partnerships between research institutions to be maintained once the war is over. There is growing evidence that mobile scientists can play a brokering role across non-migrant colleagues and global networks. The long-term policy aim should be to support genuine brain circulation and mutually beneficial partnerships between countries rather than pursuing brain gains at the expense of each other.

Beyond its immediate neighbours, many Ukrainian scientists collaborate with colleagues across the world and research institutions and universities are opening their doors to welcome them. At some point in time, these scientific refugees will be confronted with a choice to stay or return. This will not be easy but there are a number of rules and regulations, e.g., in relation to the portability of research grants and fellowships, that can be adjusted to lower the barriers to returning. Whilst international funding, particularly in Europe, can play an important role, removal of some of the restrictions on how and where national public research funds can be spent could have a substantive and sustainable impact. Individual mobility and exchange can provide the basis for productive future partnerships between Ukrainian research institutes and universities and their counterparts across the world.

As detailed above, there has been a lot of focus on welcoming refugee scientists, many of whom are senior researchers, who with the right conditions can play a critical role in rebuilding Ukrainian science in the future. At the same time, it is estimated that around 100,000 scholars have remained in Ukraine. Some of them are struggling to continue with their research and teaching responsibilities, while many others will hope to return to these duties once the war is over. A survey of young Ukrainian researchers in March 2022 and a separate initiative from senior Ukrainian scholars and diaspora both stress the importance of remote assistance, noting that the COVID-19 pandemic had already prompted a dramatic change in working practices for many scientists**.** Digital tools and virtual open access to scientific data and publications, particularly if combined with international networks, can provide a basis for much research to



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continue even when research institutions are closed, or scientists are also contributing to the war effort. This, in turn, can provide a platform for re-launching Ukrainian science, which is an essential first step both for Building back a better innovation ecosystem in Ukraine and for developing and implementing evidence-based policies as part of the broader recovery effort once the war is over.

## What are the key considerations for policy makers?

- Considering the risks posed by "brain drain" to the future of science in Ukraine, OECD countries should aim to **promote genuine brain circulation** and the **establishment of sustainable and productive long-term partnerships** with Ukrainian scientific institutions.
- Digital tools and open **access to scientific data and publications can provide a basis for much research to continue remotely** even when research institutions are closed, or scientists are also contributing to the war effort.
- **Individual mobility and international networks can provide the basis for productive future partnerships** between Ukrainian research institutes and universities and their counterparts across the world.
- Policy measures to support refugee scientists from Ukraine should be designed from the outset to ensure that they are able to **maintain strong links with their home institutions and colleagues**, so that the current brain exodus can be rapidly reversed once the war is over.
- The **Ukrainian scientific diaspora should be considered as a strategic asset** both for their country of origin and their country of destination. With appropriate support, they can play an important role in brokering or building partnerships.



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## Additional Reading

OECD (2022), *Rights and Support for Ukrainian Refugees in Receiving Countries*, OECD Publishing, Paris, https://doi.org/10.1787/09beb886-en.

OECD (2022) *Building back a better innovation ecosystem in Ukraine*, OECD Policy responses on the impacts of the war in Ukraine, in preparation

Ukraine Country Dashboard. OECD-EU STIP Compass (2021). https://stip.oecd.org/stip/interactive-dashboards/countries/Ukraine

OECD (2021), Education at a Glance 2021: OECD Indicators, OECD Publishing, Paris, https://doi.org/10.1787/b35a14e5-en.

Appelt, S., et al. (2015), "Which factors influence the international mobility of research scientists?", *OECD Science, Technology and Industry Working Papers*, No. 2015/02, OECD Publishing, Paris, https://doi.org/10.1787/5js1tmrr2233-en.

Caroline Viola Fry (2022) Bridging the Gap: Evidence from the Return Migration of African Scientists. Organization Science 0(0), https://doi.org/10.1287/orsc.2022.1580

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