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SCIENCE AND INNOVATION IN UKRAINE: APPROACHES TO POLICY MAKING IN TIMES OF WAR

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The full-scale war started by Russia in Ukraine has caused many challenges to economic development, the overcoming of which is hard to be imagined without the research and innovation. Rebuilding R&I became another challenge for Ukrainian policymakers. Thus, ***the purpose of the paper*** *is to analyze the R&I policy of Ukraine during the war caused by Russia and to develop policy recommendations for the postwar recovery. To achieve it, we used several methods, in particular expert opinion generalization, relevant scientific and policy literature analysis, and statistical analysis.*

The paper considers three approaches to innovation policy-making at crisis time: produce; procure; repurpose. Currently, Ukraine uses mainly the second one, by buying and receiving modern armament and equipment. Meanwhile, there were some innovative developments in Ukraine, which are not produced in sufficient quantities. After the war, Ukraine couldn't buy armament due to fiscal constraints. Thus, in the short-run period, the government should reorient efforts toward repurposing of current developments. However, such an approach is not sustainable in the long-run period, when the development of a broader S&T base is required to create a solid base for further repurposing in emergency cases. The war caused massive damage to Ukrainian R&I potential, which by now is not fully measured and quantified. There are two types of damage: physical loss of research and innovation

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infrastructure (e.g. research facilities, and high-tech enterprises) and «brain drain», both of which should be the focus of R&I policymakers. Therefore, a set of policy measures is proposed to address the war-led challenges in R&I.[3]

Key-words: *R&D and innovation policy, science, war, damage, recovering, economic development*

The full-scale war started by Russia in Ukraine has caused a lot of challenges for economic development. Overcoming those challenges is hard to be imagined without the research and innovation. At the same time, rebuilding R&I becomes another challenge for Ukrainian policymakers. Thus, **the purpose of the paper** is to analyze the R&I policy of Ukraine during the war caused by Russia and to develop policy recommendations for the postwar recovery.

Considering the number of war conflicts around the world during the last century, it is crucial to analyze different experience to identify a proper benchmark for research and innovation policy for Ukraine and take key messages and approaches to rebuild our R&I policy and design better policy measures. There is an objective reason why it is impossible to use a single solution as wars took place in different time periods, conditions, and size and economic structure of countries vary a lot, etc.

However, the common approach for R&I policy is the acknowledgment of the crucial role of science and technology in war and post-war recovery. Mobilizing science during WWII in the US "...had large effects on the direction and location of U.S. invention and high-tech industrial employment, setting in motion agglomeration forces which shaped the technology clusters of the post-war era" [1]. Duy Dung Thin stated that S&T output was considered by the Vietnamese government as a tool for hunger and poverty elimination within a short period of time and for economic restoration [2].

The International Labor Organization considers post-conflict recovery through the perspective of local economic development (LED). We agree that this approach is relevant to Ukraine given its size and decentralization process. LED initiatives among others should include the promotion of PPP, business development services, stimulation of innovation, etc. [3].

Stimulation of innovation is a part R&I policy, whose development is not a trivial task during wartime. Leadbeater C. (2020), a NESTA expert, analyzed three approaches to R&I policy at crisis: produce, procure and repurpose [4]. Each approach

[3] The publication was prepared within research project on "Evaluation of Innovative Development and Structural Transformations in the Economy of Ukraine" (State registration № 0119U103803).

has pros and cons, but none of them is sustainable for a longer period of time. Policymakers should activate purchase and repurpose as an immediate crisis response.

Ukrainian scholars didn't pay a lot of attention to R&I policy-making during crisis times. Some of them treat innovation as a part of anti-crisis management. The most of studies on R&I policy were focused on intensifying the interaction between science and business, designing a policy mix to stimulate innovations, rebuilding research system, etc. [5-8].

Research methodology. To achieve the main purpose of the paper, we use several methods, in particular expert opinion generalization, relevant scientific and policy literature analysis, and statistical analysis.

Main results. Before the war in February 2022, Ukraine had 2nd rank by area and 9th rank by population in Europe. However, its economic performance was rather poor. The GDP level is lower than it was before the independence in 1991, while the economic development is not sustainable. In 2021, GDP per capita was about 4100 Euro, and real GDP growth was 3.4% only. It makes Ukraine a low-middle-income country. The unsuccessful economic development of Ukraine was accompanied by a transformation of research and innovation systems. There were a number of attempts to use innovation policy tools and incentives, but their outcomes were not quite good because the overall business conditions were rather bad.

The war exacerbated the existing problems in the economy and brought massive damage to economic activities. According to a number of studies and forecasts, a fall of the real GDP of Ukraine is expected between 35 and 50% [9]. Such a wide range of estimation was associated with high uncertainty about the war duration and damages to infrastructure, including the industrial one as well as with the great difference between individual methodological approaches.

Accordingly, there is a wide range of estimations as to damages suffered and costs necessary to recover the Ukrainian economy. The latter vary from 150 bln USD to 1000 bln USD [10]. These estimations are based on different assumptions and recovery models. It is obvious that just simple rebuilding of the economy is not enough for sustainable development. Moreover, as Ukraine has become a candidate for EU membership, it forces Ukraine to speed up the integration into the EU value-added chains, and digital and green transformations under the tremendous changes in human resources and limited access to capital.

It should be noted that Ukraine has no successful experience in directed structural transformations and innovation-based growth support. It makes the after-war recovery a huge challenge for the Ukrainian government.

The innovation policy of Ukraine has a long history since 1991 with both successes and failures. In recent years, there has been a demand for reforming research policy, as science and research are the main sources of innovations [11].

Thus, in 2015 the new law on S&T activity was adopted. But it did not lead to the expected results, as the law provisions were not properly addressed in the government activities, e.g. creation of the National Research Fund took a very long time and the government didn't support its activities with sufficient financing.

Moreover, after the new Law was adopted and new bodies in R&I policy domain were created, e.g. National council on S&T development, the government's attitude to S&T activity worsened. Thus, the R&D intensity of GDP dropped from 0.48 to 0.43% during 2016-2020 [12]. This significantly limits researchers in their abilities to produce effective solutions to solve urgent problems during wartime and in post-war period.

As for innovations, the new law on support and development of innovation activity, whose first draft was prepared in 2015, has not been adopted yet. Meanwhile, in 2019, the government developed the so called National Innovation Strategy 2030. It was aimed at enabling and promoting scientific research and the transformation of innovative ideas into commercial solutions. The implementation of the strategy should address the existing gaps in legal frameworks, improve education, consolidate the entrepreneurial culture, and strengthen the national innovation infrastructure. Other objectives include promoting private R&D and boosting the demand for innovation [13]. However, Ukraine repeats the same mistake – good ideas with poor (or wrong) implementation. The Action plan for the Strategy was not developed in time and was only approved more than 1 year after the adoption of the very Strategy. One of the reasons is that the civil service has no specific training in drafting policy [13]. In other words, the ministry staff, even those who were hired by the Ministry within the public government reform, lacks of skills in policy making.

The UNECE experts' assessment has been a key source to summarize the weakest points of the Ukrainian innovation policy. According to them, there are poor coordination and complementarities with SME development and industrial policies, inadequate institutional and legal frameworks, and a miscoordination at the central government level (and we can add the same at the regional level too). Also, in the context of innovation policy tools, the biggest challenge is supporting relations and linkages between science and industry. It should include clusters, business networks, innovation infrastructure, mobility, etc. [8].

According to the latest data, the companies' innovative activities dropped to less than 10% in 2018-2020 [14]. The main factor was the tremendous drop in reporting non-technology innovations combined with a drastic cut of the company sample from 8 to 2 thousand. In addition, we could assume that the companies' representatives who

fill in statistical questionnaires are not fully aware of what "innovation" means because the explanations provided by the statistical office are not sufficiently clear. Also, we should note that implementation of technology innovations decreased slightly, probably, due to financial constraints induced by COVID-19.

In the Global Innovation Index 2022, Ukraine ranks 57th out of 132 economies in terms of innovation performance [15]. The poor performance is in market sophistication, institutions, and infrastructure. So, the R&I policy making should be focused on [13]:

- increasing the share of high-tech and medium-high-tech goods in total manufacturing;
- increasing public and private investment in R&D, strengthening industry-science linkages, and encouraging technology upgrading;
- commercializing innovative ideas by stimulating demand in the domestic market.

The war, obviously, did not only exacerbate the existing problems, but also created new challenges in the R&I area. It caused a massive damage to Ukraine's R&I potential, which by now is not fully measured and quantified.

There are two types of damage that should be in the focus of R&I policymakers: physical loss of research and innovation infrastructure (e.g. damages of research facilities and high-tech enterprises) and "brain drain".

The latter one is the most dangerous for post-war recovery. Unlike the restoration of buildings and purchasing of new equipment, human resources could not be simply substituted. It takes plenty of time to grow and educate a researcher. This is also a challenge for Ukraine as many pupils and students might not return to Ukraine, even after the end of the war.

During the first months of the war, there was a big outflow of people from the regions under attack. According to the UN and ILO, amount of people who left Ukraine or fled the war to another region was 20-25% of total population [16]. About 6 mln people left Ukraine, mainly for Europe, USA and Canada. Those people are qualified workers: over 50% have high education degree, and about 11% have several diplomas or scientific degrees [10].

Given that around 50% of Kyiv and Kharkiv population left in March-April [17] and it is these two cities where the largest share of research personnel is located (more than 50 thousand R&D performers), we assumed that approximately 20-25 thousand R&D personnel have left their permanent place of living. Only a small share continued working on R&D projects remotely (thanks to COVID19 such work had been widely introduced and properly organized earlier), mainly in the social sphere and humanities.

The above estimates are well in line with other expert assessments. George Gamota suggests that some 22 thousand researchers - mainly women with children - have fled the war [18]. Among other things, it means that many R&D projects in Ukraine were interrupted or even cancelled.

However, the liberation of territories and increased safety in Kyiv and some other regions facilitated a reverse flow of people. Meanwhile, in June 2022 National Academy of Sciences of Ukraine reported that around 17% of its staff were out of their permanent place of living. In absolute numbers, that makes about 4.6 thousand academy staff workers, of whom about 2 thousand are researchers [19].

In addition, about 600 thousand students and pupils and 23 thousand pedagogical staff members who left Ukraine [20]. Such "brain drain" can have a long-term effect on the Ukraine's economic recovery as there is a big risk of losing talented youth and researchers against the background of the measures taken by the "hosting" countries to integrate Ukrainian refugees. The EU has launched various platforms, e.g. #ScienceForUkraine (https://scienceforukraine.eu), and ERA4Ukraine, and a special call was announced in MSCA Horizon Europe, to support Ukrainian researchers at risk. The National research foundation of Ukraine aggregates programs and grant calls for Ukrainian researchers, while its direct task of R&D financing is suspended due to budget cut [21].

Thus, many researchers who get scholarships in foreign universities and research institutions might choose to stay there after the war as they get not only the access to modern scientific equipment, but also to different integrational support (e.g. language learning, etc.)

By now, there have been no official declarations on any planned measures to retain researchers in Ukraine and to return those who left the country. Meanwhile, the Recovery plan for the economy is being developed, which may force the government to address the issue.

Speaking about the physical losses in R&I area, a representative of the Ministry of education and science of Ukraine reports that at least 68 research institutions were damaged, 2 destroyed completely, and 9 research facilities are under occupation. In general, around 15% of the research infrastructure in Ukraine was damaged (as of September 2022) [22]. This includes unique research facilities, e.g. laboratories of the Institute for Safety Problems of Nuclear Power Plants and the nuclear subcritical installation "Source of Neutrons" at the National Science Center Kharkiv Institute of Physics and Technology.

Regarding innovation activities, it should be noted that Ukraine is significantly lagging behind the EU average, which was 53% in 2018-2020 according to the latest available data.

During the first months of the full-scale war, about 50% of enterprises terminated their activity either completely or nearly completely [23]. However, that decline took place during the short-term shock period at the beginning of the war, and after a few months, as the situation becomes more stable, enterprises have started recovering their activities. In October 2022, the share of companies that are not working or loaded less than by 25% of total capacity decreased to 8%. And the share of those who loaded more than 50% increased to 70% [24].

However, most of the SMEs (over 50%) don't have enough financial resources to survive in long-term war and lack of capital is an obstacle for them to recover their activities [23].

Thus, the implementation of new technologies and innovations seems unclear given that 80% of innovation expenditures in pre-war time was the companies' own funds [25]. So, the role of government in boosting innovation and technology in order to upgrade the economy gains even more importance.

The central and regional governments (e.g. Lviv regional military administration) launched a number of programs and initiatives to support the relocation of enterprises into safe regions. During the first 6 months of the war about 750 enterprises were relocated and about 300 are in the process [26].

The relocation process might have a positive impact on industrial parks development, first in western Ukraine, and later across the whole of Ukraine, when the war has been finished and industrial activities start to recover. Actually, already during the war, a number of industrial parks have been registered. In addition, the relocation could force companies to implement innovations related to the adaptation to new markets, raw materials and inputs, new logistics etc. Overall about half of the existing companies in Ukraine need a business transformation, e.g. innovative approaches, of which up to 20% have already been transformed [27]. The demand for innovations will increase due to the implementation of the best available technologies and management practices. About half of the enterprises are considering the issue and another 10% have confirmed their plans to implement such measures [28].

Given that financial constraints are a huge problem for many SMEs, the government should develop and introduce a set of financial instruments to support enterprise recovery based on modern technologies.

So, nowadays Ukraine should re-examine its R&I policy adding to it a challenge of recovery in the short-run period. One of the studies on R&I policy at crisis time suggests three approaches to innovation policy, that a country could choose as a response to the crises and war: **producing; procuring;** or **repurposing** [4]. Let's explore all of them in the Ukrainian context.

The first approach - **producing** innovation - obviously require a broad base of basic and applied research empowered with an effective mechanism and tools to turn scientific knowledge into a final product. Thus, it requires a lot of time and resources. Such an approach was used by the leading states, e.g. US and UK, during WWII. It is important that private companies took an active part in R&D generally performed by government-funded laboratories.

As an indicator that shed some light on country's capacity to produce its own innovative products, we use the ratio between basic research, applied research, and experimental developments. In Ukraine, the ratio is about 1:1:2 with R&D intensity at 0.4%, while in France it is close to 1:2:2, and in Austria, it is 1:2:3. R&D intensity in France and Austria are 2.2% and 3.1% respectively [29]. The data shows that Ukraine is lagging in applied research which is a crucial chain between scientific knowledge and product. Even in such conditions, Ukrainian companies and scientists were able to create competitive defense-oriented products (e.g. UAV, antitank complex Stuhna, tactical rocket Neptune etc.), but the scale of production was quite low and was not sufficient in wartime. The war forced the government to change its attitude towards military innovations and a call was launched for military-tech startups so that winners could receive up to 35 thousand USD for their product/solution. There was also a call on dual purpose technology announced by the Lviv regional administration. Also, a group of businessmen organized Innovation Defense Initiative (https://idi.camp/) to select and support the best solutions for army needs. So, a defense hackathon was organized with the support of the Ukrainian Startup Fund, Ministry of Digital Transformation, Ukroboronprom (Ukrainian defense industry company) and some IT companies.

The second approach consists in **procuring innovation**. It is a quite fast option to implement. This approach is common for many countries which was clearly demonstrated by COVID19 response. However, there are some risks associated with the purchasing of innovations. First of all, these are the unclear/uncompetitive purchasing tenders and lack of coordination since in short run there is no full information neither about the needs nor about all possible purchase options. Also, there are specific regimes in the trade in military and defense-related innovations. Usually, the price for them is usually very high while many up-to-date innovations are not supplied to global markets due to political and security reasons.

Currently, Ukraine is heavily dependent on imported/purchased defense-related innovations since the country's own innovations are still not implemented into large scale production. Moreover, many production sites were destroyed during the war, so purchasing is the only option for prompt response during the war.

After the war, Ukraine will be probably unable to buy armament due to fiscal constraints. Thus, developing its own defense-oriented technologies is a key to this country's future security. Later on, can be turned into civil economy and put on commercial way.

The third approach is **repurposing** existing technologies and developments. According to British experts, it is the best option for innovation policy to response a crisis [4]. The idea of this approach is to adjust the existing R&D to a new challenge. It is cheaper than inventing something from a scratch or purchasing on global markets. This approach was the key to developing a vaccine for COVID-19 by Oxford University. They used the already developed platform ChAdOx1 designed to produce vaccines for certain pathogens to develop a vaccine for COVID19 [4]. Another example is the case of ventilators manufacturing. One group of companies, including the globally known Dyson, in cooperation with universities decided to develop brand-new ventilators, but they failed. Otherwise, another group of manufacturers succeeded in producing existing types of ventilators with some level of modernization and adjustment.

Repurposing cases were also known during the WWII when machinery plants mastered production of tanks and other military equipment.

Of course, in modern times the complexity of goods is much higher and repurposing requires a well-developed industry and highly qualified engineers to change production lines in a short-time period.

A few cases of repurposing can be found in Ukraine as well. For example, the Ukrainian company Eleek is a manufacturer of e-bikes. It adjusted an existing model of e-bike for the needs of the Ukrainian Army [30]. Another company, namely Colon Motors before 2022 developed light commercial electric vehicles, had been developing electric light commercial vehicles before 2022, but then pivoted activities to develop a buggy for the Army's needs. Meanwhile, we did not find examples of repurposing in the state R&D sector[4], which can be associated with the rigidity and inflexibility of the bureaucratic system and a sharp reduction in the government funding of R&D.

British experts suggest that the most effective innovation in crisis and wartime relies on adaptation that is on the use of available knowledge and skills for repurposing the current technologies [4]. Meanwhile, in a long-term period such an approach will no longer be sustainable because industrial pivoting will be limited to existing science and technology bases. Therefore, the development of basic and applied science is crucial for producing innovative solutions in response to unexpected shocks.

[4] In 2014, as a response on emerged need of Ukrainian army, researchers of several research institutions created R&D center "Borei" to develop Ukrainian hemostatic.

One of the key points for the implementation of repurposing as an innovation policy approach is that it requires proper institutions and persons who are able to quickly integrate the existing opportunities to solve emerging challenges [4]. The ability for fast repurposing should be embedded into post-crisis economic and social strategies.

Despite the lack of government support, a few institutions that tried to foster innovative development emerged in pre-war times. And since the war started this process has become more active. As an example, in March 2022, the Association of Industrial Automation of Ukraine initiated the establishment of the Ukrainian cluster alliance (UCA), a multi-industry nationwide union of enterprises, business associations, clusters and cluster organizations of Ukraine that strive to increase their competitiveness by implementing the principles of cluster cooperation, industrial, digital and green innovations, automation and effective interaction with the government. By now, it is the largest union of business clusters with 32 members [31].

The UCA started to implement many initiatives in order to support manufacturing and foster innovative activities and cooperation between enterprises and their internationalization. Among them free-membership in CSIA, cooperation with the European Cluster Alliance and European Cluster Cooperation Platform, manufacture of Medical kits for Ukrainian Army Forces, innovation matchmaking events etc. It is worth to mention the UCA's efforts on the inclusion of Ukrainian companies in Innovation Communities of the European Institute of Innovation and Technologies. This work is quite successful as the UCA became a partner of EIT Manufacturing and launched the "Pre-accelerator in Ukraine – powered by EIT Jumpstarter" program.

Such activities are oriented not only on the recovery of business activity in short term period, including export but rather on the creation basis for long-term sustainable development after the war, based on digitalization and other technology innovations.

Meanwhile, bottom up initiative is not enough to maintain recovery of economy on innovations. And government should take more responsibility on adjusting innovation policy to the war and post-war needs. This is acknowledged by the UCA and is the reason why UCA (2022b) develops a set of proposals for the government that include the following measures [32]:

- Buy Ukrainian. It is a program for the export of Ukrainian goods and support for their promotion/certification in the world, already offered by the State Enterprise Development and Export Support Office.
- Integration into GVC. It is a program to support the integration of Ukrainian enterprises into European and international chains of added value (by introducing a broad industrial dialogue between Ukraine's leading business associations and clusters and European and world organizations), which requires immediate coordinated actions

by business and the Government to save enterprises, that suffered the most from Russian aggression.

- Inno-Integration is a program of accelerated inclusion and support of Ukrainian innovative enterprises in the relevant European programs of innovative development, and dual digital and green transition. The restart of the industrial dialogue at the level of leading European associations is expected, as well as the acceleration of integration into the European value-added chains of companies from the most mature sectors of the high-tech industry (auto industry, mechanical engineering, biopharma, metalworking, engineering, and industrial automation).
- Standardization is a program to support technical regulation and accelerated transition of Ukrainian enterprises to international technical standards.

These and many other proposals were submitted to the draft of the Ukraine's National Recovery Plan, which was initiated by the President of Ukraine. In the end of April, he created the National Council for the Recovery of Ukraine from the Consequences of the War, which includes 23 working groups, including the "Education and Science" group. The draft of Ukraine's National Recovery Plan, which was developed and presented for public discussion in July 2022, at first glance, has a systemic nature and ambitious goals. The government considers it as a unique opportunity not only to compensate for the losses caused by the war but also to speed up economic growth and improve the quality of life in Ukraine. It consists of 17 national programs, 850 projects, and has a funding of $750 billion USD [33]. However, according to foreign experts [34] and Ukrainian experts responsible for specific directions, the document cannot yet be considered complete. Indeed, it should be noted that the presented projects and measures are not coordinated with each other and with other groups, and some projects may be part of others. There are similar projects, such as those related to the defense and security sector. Plans to increase innovation activities are only mentioned in the context of mechanical engineering development. Plans for the restoration of science are included in the national program "Improve Education system" with a funding of 5 billion USD. All this leads to the disappointing conclusion that science and innovation are at risk of once again not becoming a decisive factor in the development of Ukraine.

To address gaps in the developed Recovery Plan and search for effective tools for cooperation between donors, the German Marshall Fund has developed recommendations for supporting Ukraine's recovery from the perspective of the main recovery donors. The main idea is to create the Recovery Ukraine Platform, which should become the basis for partnership between Ukraine and donors [35].

Unfortunately, neither the experts of this fund nor the experts of the World Bank in their recommendations for the recovery of Ukraine pay any attention to the

development of the R&D sector. However, they emphasize the need to adhere to the "build back better" principle, which essentially means that recovery should be based on new and/or more efficient technologies. In other words, science and innovation should be considered as the driving force of economic revival and, accordingly, this should be enshrined in political documents.

If we talk about the actions of the Ukrainian government, their current approach to economic development, including the sharp cut of R&D funding and the lack of support for innovation, is not suitable for maintaining sustainable economic growth in the long term period. Because a well-developed scientific and technical sector is necessary to create a strong foundation for further reprofiling in emergency situations. However, even despite the successes of domestic defense developments, the government continues to ignore the role of science. For example, in the draft State Budget of Ukraine for 2023, approved in the first reading, expenditures for scientific and scientific-technical activities were planned in the amount of UAH 11.8 billion, of which from the general fund of the state budget - UAH 8.1 billion [36], which was in actual prices less than similar expenditures in 2021 by UAH 1 billion. Accordingly, the share of government budget allocations for R&D in the expenditures from the general fund of the state budget compared to 2021 will be halved.

Conclusions

The changes in Ukraine's science and innovation policy, caused by the war, are discussed in the context of key challenges for post-war recovery, including physical destruction of research and production infrastructure, brain drain, and development of approaches to enhance innovation activities in crisis conditions.

Overcoming the first of the above mentioned challenges is more related to proper financing and coordination of investments in research and innovation infrastructure, while the second challenge is primarily linked to a change in the approach to science and innovation policy that should create favorable conditions for the return of scientists and innovators to Ukraine.

Regarding innovation policy approaches, the government currently relies, in its science and innovation policy, mainly on the procurement of innovations, especially military ones, which occurs both formally and informally. However, in our opinion, after the war, Ukraine needs to shift its focus to producing its own innovations, primarily in the defense sector, and to develop its scientific and technological base, taking into account the most likely threats and risks to the country's development.

The expert community, business community, and scientists have developed a series of political measures to overcome the challenges of the war in the scientific and innovation spheres. However, the government does not take them seriously enough and

does not demonstrate a long-term strategic vision for post-war recovery, effectively shifting the initiative onto the shoulders of international donors who have implemented unprecedented measures to support Ukrainian scientists and innovators both at the level of individual countries and the EU as a whole. Among them, the initiatives within the EU's research and innovation framework program "Horizon Europe" are worth noting separately, including special conditions for the participation of Ukrainian researchers in the program through the Marie Skłodowska-Curie actions, a project to support innovative SMEs and their integration into the European ecosystem with a funding of 20 million euros, the cancellation of Ukraine's fees to the "Horizon Europe" program for 2021-2022.

Global experience shows that science and technology are not only one of the key factors of a country's long-term economic and social development, but also the most important factor in overcoming the consequences of crises and wars. Countries that managed **to turn science into a source of development** have achieved significant economic results and a high standard of living.

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НАУКА ТА ІННОВАЦІЇ В УКРАЇНІ: ПІДХОДИ ДО ФОРМУВАННЯ ПОЛІТИКИ В УМОВАХ ВІЙНИ

Повномасштабне воєнне вторгнення РФ в Україну призвело до багатьох викликів для економічного розвитку, який на сьогодні важко уявити без внеску наукових досліджень та інновацій. Перебудова науково-інноваційної системи стає ще одним викликом для українських політиків. Метою статті є аналіз наукової та інноваційної політики в Україні під час воєнних дій та розроблення

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ряду рекомендацій для післявоєнного відновлення. Для цього було використано декілька методів, зокрема, узагальнення експертної думки, аналіз відповідної наукової та аналітичної літератури та статистичний аналіз.

У статті інноваційна політика розглядається з позицій трьох підходів до її формування в умовах кризи: виробництво інновацій, купівля інновацій та перепрофілювання наявних технологій і розробок. Наразі Україна використовує переважно другий підхід, купуючи та отримуючи сучасне озброєння та техніку. Водночас в Україні з'явилися інноваційні розробки, рівень виробництва яких недостатній для задоволення власних потреб. Після війни Україна навряд чи зможе купувати необхідне озброєння через фінансові обмеження. Таким чином, уряд має у короткостроковому періоді переорієнтувати зусилля на перепрофілювання існуючих розробок. Однак такий підхід не є сталим у довгостроковому періоді, коли потрібна достатньо широка науково-технічна база, що в екстрених випадках забезпечуватиме швидке перепрофілювання розробок під нагальні потреби. Війна завдала величезної шкоди науково-дослідницькому потенціалу України, який на сьогодні ще не повністю виміряний та кількісно визначений. Існує два типи збитків: фізична втрата дослідницької та інноваційної інфраструктури (наприклад, наукових установ і високотехнологічних підприємств) і "відплив мізків", на яких повинні зосереджуватися політики, які займаються прийняттям рішень у сфері науки. З огляду на зазначене пропонується набір політичних заходів задля вирішення викликів, до яких призвела війна, у сфері науки та інновацій[7]

Ключові слова: *ДіР, наукова та інноваційна політика, наука, війна, збитки, відновлення, економічний розвиток*

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