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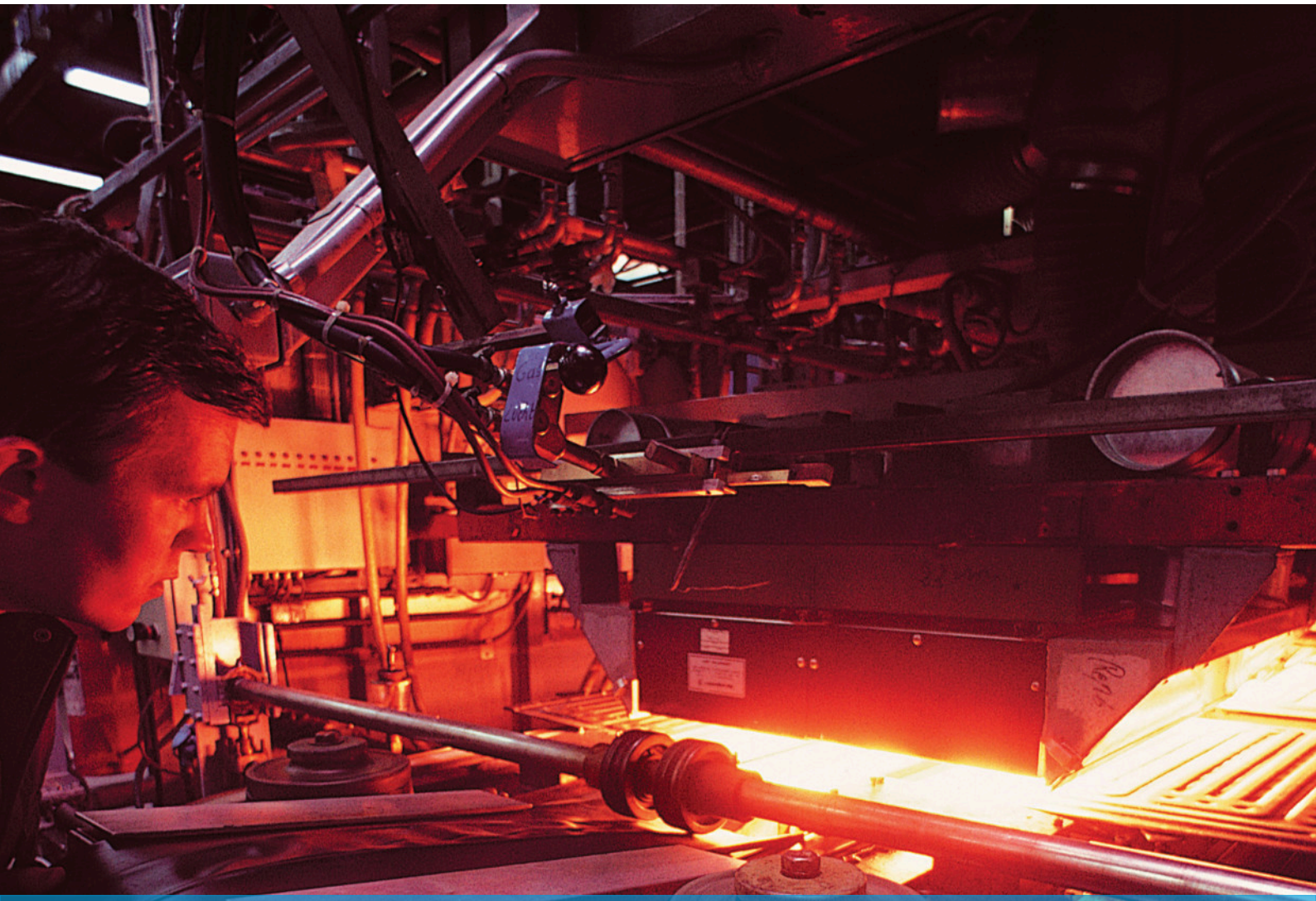

Diversifying and rebuilding the Ukrainian economy

Application of the DIVE tool

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Diversifying and rebuilding the Ukrainian economy

Application of the DIVE tool

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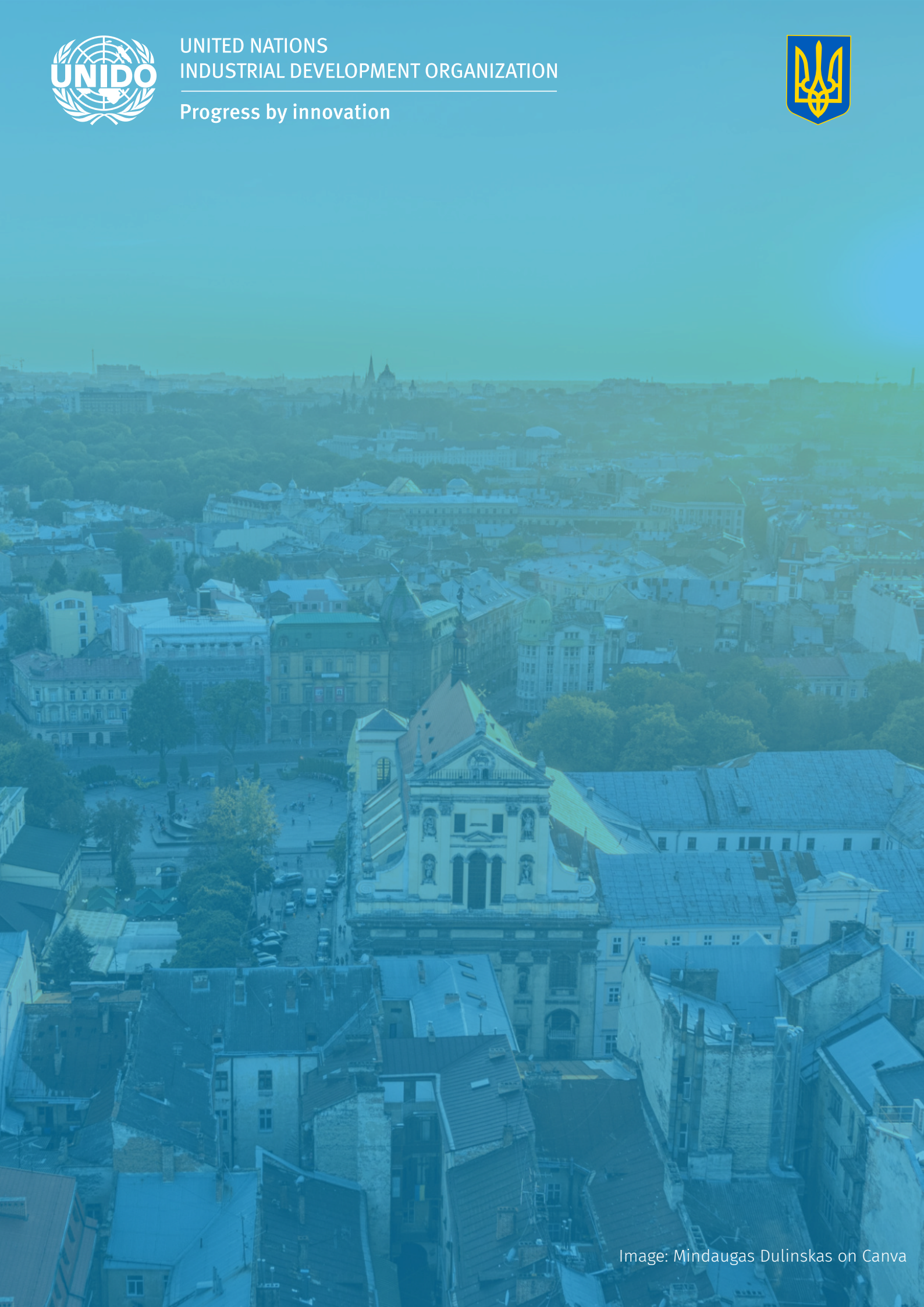

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Introduction

Economic growth and prosperity rely heavily on the structural transformation of economies. This dynamic and evolving process expands the array of products a nation can export and refines its production capacities. Historically, the evolution of the production and export basket has not merely stemmed from 'natural progress' (or adherence to what economists generally call static comparative advantage). Instead, it has been significantly influenced by active policy interventions that have promoted the expansion of an economy's productive capabilities, especially in response to market stimuli, such as pricing dynamics and emerging opportunities or challenges.

In well-functioning and stable economic environments, private enterprises are the primary agents of structural change through new investments, specialized training and cost-discovery operations. But even in such contexts, market failures can stall the shift from existing specializations, rendering structural change challenging or impossible. This is where the role of active public policies, encompassing diversification, industrial strategies, and innovation drives, becomes paramount. Such policies can catalyze sustainable diversification, ensuring an economy remains adaptable and resilient.

The full-scale invasion of Ukraine has underscored the importance of economic diversification, but equally crucial is the need to rebuild and reconstruct its industrial capacities. The damages inflicted have resulted in the loss of critical industrial capabilities and resources, and for Ukraine to bounce back robustly, it must focus on diversifying its economic structure and rebuilding its lost capabilities.

Successful stories of industrial development do not trace back to a common and unique path. Some countries leverage "horizontal policies," sector-neutral strategies designed to cultivate new productive skills, such as fostering human capital or entrepreneurial expertise, eliminating trade barriers, reducing bureaucratic red tape, or enhancing credit accessibility. These policies promote cost-discovering activities in new areas and foster diversification.

In contrast, "vertical policies" – specifically designed to bolster products or sectors – have been cautiously approached. The intricacies and potential pitfalls of identifying 'promising' sectors and crafting the 'right' policies discourage many governments. Nevertheless, while horizontal policies are pivotal in creating an economic environment conducive to diversification, they might not be sufficient to guarantee comprehensive diversification when market failures – such as those that emerge in the aftermath of a severe conflict – are pervasive.

For Ukraine, the lesson is clear. While pursuing economic diversification is vital, it is equally crucial to reconstruct and upgrade its industrial and specialized capabilities. Numerous studies highlight that trade diversification can offer multiple advantages, ranging from economic resilience to risk mitigation (Agosin, 2007; Hesse, 2008; Cadot, Carrère, and Strauss-Kahn, 2011). Therefore, a balanced blend of horizontal and vertical policies tailored to Ukraine's unique needs will be paramount for its future growth and prosperity.

In this report, we apply UNIDO's tool DIVE (Diversifying Industries and Value Chains for Exports) to help the Ukrainian government select potential targets for vertical and horizontal industrial policies to diversify and strengthen its economic base. Our analysis is based on three critical premises. Firstly, we consider how the current conflict has impacted current production and trade specialization using DIVE in conjunction with qualitative analysis (primarily interviews with

experts)[1] and recent trade data. A second important consideration is the changing geopolitical context in which the post-conflict Ukrainian economy will emerge. The trend of westward orientation and deeper integration within the European Union will most likely accelerate. This consideration implies that diversification policies (and industrial recovery in 'old' specializations such as metallurgical products) must be tailored to deeper regional integration with the European market. Our targeting exercise for identifying opportunities for diversification of the Ukrainian export basket (DIVE targets) considers the potential demand from EU countries weighted by their 'economic dimension' (i.e., size of the GDP) and distance from Ukraine[2].

The last premise on which we base our analysis on is the changing nature of the within-country economic geography of Ukraine. The war is affecting Ukrainian regions in a highly asymmetric and heterogeneous way. Regions bordering Russia have suffered the most from direct damage, loss of human capital and a deep cut in cross-border economic relations. The effort of industrial recovery should explicitly consider the need to avoid the future of Ukraine, which is one of deep regional imbalances.

The DIVE tool employs a three-step analysis[3] to produce findings that inform diversification policy strategies. In step 1, we assess the current specialization basket to analyze its level of complexity vulnerability and (for the main specializations) a qualitative assessment of war-related damages and the potential for industrial recovery. In step 2, we briefly study the characteristics of recent changes in the composition of Ukraine's production basket. We focus on 'export surges,' labeled in this report as New Entries (NE) in the export basket. This allows us to assess the country's recent (pre-war) ability to diversify away from its initial specialization relative to other countries with a similar level of development (Low-Middle-Income countries). In the last step, we apply the DIVE methodology to identify sets of products/sectors representing desirable and feasible targets for diversification policy. The DIVE tool identifies so-called 'short jumps'—or products that are not yet being exported with a strong specialization but require productive capabilities that are likely to be already available in the Ukrainian economy—as well as long jumps' – or products that represent novel areas of structural transformation. The DIVE tool considers the degree to which a country's diversification strategy is feasible for this latter set of products, which generally represents a more interesting pathway towards structural change (Hausmann et al., 2007; Coniglio et al., 2021). Given its strategic importance, considering the above-mentioned need to avoid the war from translating into deep territorial inequalities, we explicitly consider the regional dimension for all these steps. In addition, expert opinions collected through in-depth interviews have been used to validate and enrich the DIVE analysis.

Several key points emerge from the analysis. In Figure 1, we provide a snapshot organized into three main themes: structural change before the conflict, the effect of the conflict, and the 'way forward' for sustainable and effective diversification policies. We refer the reader to the specific sections for details and insights.

[1] The qualitative analysis - that has been employed for integrating/complementing the analysis based on the DIVE tool - is based on a total of 19 in-depth interviews in Ukraine with key experts belonging to public organizations as well as the private sector. Interviews with public sector and intermediate bodies representatives (n. 9) included: Ukrainian League of Industrialists and Entrepreneurs; Regional Council of Entrepreneurs of Kharkiv Region; All-Ukrainian network of experts and practitioners in regional and local development REGIONET; State Owned Enterprise "M.P. Shulgin State Road Research Institute; Confederation of Builders of Ukraine, Construction Chamber, Academy of Construction of Ukraine, Ministry of Development of Communities, Territories, and Infrastructure; Donetsk Chamber of Commerce and Industry; Ministry of Economy of Ukraine; Kharkiv Regional State Administration (during the war - Kharkiv Regional Military Administration). For the Private Sector, consultations were organized with CEO and top managers of 10 representative companies (1 - large, 6 - medium, 3 - small) from the following sectors of the economy: Machinery (5), Production of non-metallic mineral products (2), Wood processing and manufacturing of wood products (1), Chemicals and pharmaceuticals (2), located in the North-East (Kharkiv, Kremenchuk, Piatyhirs'ke village, Svitlovodsk) and Eastern region of Ukraine (Dnipro).

[2] UNIDO (2023) is a study that rather adopts a prioritization approach based on employment considerations and input – output analysis.

[3] Please see the Appendix A and B for some more technical explanations of the concepts and equations.

Figure 1 | Structure of the report

Data source: UNIDO elaboration.

Pre-war diversification and production capabilities

Generally, the pre-war pattern of structural change was dominated by a limited degree of diversification confined to resource-based and extractive industries. Two macro-sectors account for the largest share of the export basket and new additions – or export surges: Agriculture and Metals. Interesting 'cases' of successful diversification supported by collective actions emerged. Still, according to most expert opinions, several bottlenecks – such as inefficient credit allocation, corruption, and political instability – led to an inadequate structure, a 'raw material economy' with a relatively high share of low-tech production. Specific specializations have evolved – food industry, light industry, furniture production, and the production of metal wares, as well as some still limited but important machinery productions – but a need to diversify toward more sophisticated and complex products is evident from the analysis presented in this report. Due to data limitations, a promising sector that has not been extensively covered in this report is ICT. Necessary capabilities have been accumulated in this sector, which accounts for 14% of Ukraine's total exports and might be deployed to strengthen the comparative advantage in other high-tech industries in the manufacturing sector.

The effects of the full-scale invasion of Ukraine

The non-recognized annexation of Crimea and the conflict in Eastern Ukraine affected the industrial potential of Ukraine severely, not only disrupting the supply side of the economy through direct and indirect destructions but also affecting the demand side through severed economic relations with Russia, Belarus and other countries for which trade costs have exploded. As highlighted in the analysis, the conflict had highly heterogeneous effects on production capabilities – all sectors have been affected, but some sectors/industries suffered the most. Also, the prospect of recovery seems heterogeneous. The supply and demand disruptions have been or are likely temporary for some industries – predominantly located or relocated during the conflict in Western regions. A great effort is required to rebuild the production

capabilities of most metals and machinery specializations in regions bordering Russia and Belarus (such as Kharkiv, Zaporizhzhia, Sumy, Kherson, and Mykolaiv). Productive agricultural land will need extensive interventions to recover the pre-war capacity (ex. De-mining). As discussed in the report, the reconstruction effort should direct resources and productive capabilities to new potential sectors/products that might be in demand in the internal market and the global economy. Fundamental in this respect will be strategic reorientation of exports toward the EU market as the future of Ukraine in the changing geopolitical landscape is that of a West-ward shift in economic and political relationships.[4]

A profound and problematic effect of the full-scale invasion of Ukraine is that of a change in the geography of production. North and Eastern Ukraine is suffering from multiple shocks to industrial capacity: loss of capital and infrastructure, loss of population and human resources, severed economic ties and, not less importantly, the effect of uncertainty about the future. Many industries (and individuals) are relocating to Western regions that were less affected by the war.

The way forward: The interlinked needs to rebuild, diversify and close the emerging territorial disparities.

There is a compelling need for a reconstruction effort with an explicit goal to reduce and mitigate these growing inequalities. This report offers national and international policymakers' and stakeholders' indications of possible targets for diversification and reconstruction efforts. It should be noted that industrial and diversification policy cannot disregard the need to avoid the future of Ukraine, which is featured by significant territorial disparities spurred by the war.

The geography of production will inevitably be reshaped after the war. The relocation of industries from Northern and Eastern areas toward Western Oblasts led to the transfer and recombination of capabilities in the hosting regions. Some of the population has also moved West (or abroad) and is employed in old and relatively new specializations. New specializations, such as the production of weapons (drones are a notable example), have already emerged. These products might likely represent new export specializations after the conflict. The scaling back of some industrial capabilities now focused on the war effort will probably release resources – capital, knowledge, and human resources – that might boost productivity in other related sectors, which are essentially capital- and knowledge-intensive.

Future diversification and industrial policies shall intersect regional policies. While some strategic sectors are unlikely to return to the most affected regions – for instance, some defense-industrial complexes – the production of construction materials, the recovery of capital-intensive industries damaged in the war-torn regions as well as light industries (such as those related to agricultural processing) could be promoted and incentivized in these areas. In other words, future industrial strategies should explicitly consider the risk that the war-related geographical disparities might consolidate and become a permanent feature of the Ukrainian economy.

This report is structured as follows. After summing up the main findings and results of the report, we present the main features of Ukraine's export basket in the immediate pre-war period and a qualitative assessment of the impact of the war on industrial capabilities in Section 1. This section also analyzes products added to the Ukrainian export basket since 1995. This allows for assessing Ukraine's pre-conflict ability to diversify towards relatively unrelated goods compared to the economy's initial comparative advantage (i.e.,

[4] Since 2016 the EU-Ukraine Deep and Comprehensive Free Trade Area applies. The agreement eliminated most tariffs – EU: 98.1% and Ukraine: 99.1% - and the remaining tariff barriers are relatively low. The remaining barriers that limit the access of small and medium-sized enterprises to the large EU market are mostly non-tariff and technical. This is an important area of international cooperation that will be instrumental to the diversification of the Ukrainian economy. It is important to notice that on a temporary basis, the EU has granted Ukraine full trade liberalisation, suspending import duties, quotas and trade defense measures for imports from Ukraine within the framework of Autonomous Trade Measures (ATM) Regulation (valid until June 2024). For more info we refer the reader to. EU trade relations with Ukraine (europa.eu).

structural dynamism). Section 2 presents a qualitative assessment of the changes in industrial capacity due to the ongoing war – primarily based on expert opinions gathered through interviews. Section 3 presents potential targets for future diversification policies identified using the DIVE tool. These 'targets' are categorized into four groups based on a battery of identification criteria described in the report. Section 4 concludes the report by drawing some policy remarks.

A snapshot of the main findings and results

Recent dynamics on industrial and export capabilities

The Ukrainian export basket—identified as the set of products with an RCA higher than unity for at least two years out of three—consists of approximately 200 products in the Harmonized System 4-digit nomenclature, characterized by an intermediate level of product sophisticatedness—a proxy for the level of productivity associated with export of products—equal to USD 12,847[5]. Such value is below the world average (USD 15,064) but higher than that of lower-middle-income countries (USD 10,991).

The export basket is highly concentrated in a few capital-intensive industrial sectors belonging to the metallurgical macro-sector – *2601 Iron ores and concentrated* with a share of almost 10% of total exports, *7207 Semifinished products of iron* (5.8% of total export), *7208 Flat-rolled iron, width >600mm, hot rolled, not clad* (5%), *7201 Pig Iron* (2.3%) and other metal products – and agricultural products – such as *1512 Sunflower seed oil* (9.2%), *1001 Wheat and meslin* and *1005 Corn* (both 8.5% of total exports). Only two products in the electronic industry enter the list of top specializations – *8544 Insulated electric wires* (1.6 billion USD of export in 2021, equal to 2.3% of total exports) and *8516 Electric heaters* (639 million USD). Limited space in the export basket is occupied by chemical products and machinery (one exception is 8411 Gas turbines).

For the last available data, 2021, Ukraine's Index of Structural Vulnerability (ISV) was 0.66, slightly lower than the median value in the world economy (0.68). Thus, regarding vulnerability to external competition, Ukraine is in the 134th place in over 224 countries.

The ability of a country to diversify its economy by adding new and more complex products to the export portfolio is a fundamental ingredient of structural change, socio-economic progress, and, ultimately, well-being. The Ukrainian economy experienced stable and relevant export surges– i.e., new specialization products – in 54 products. These new entries in the export basket accounted for approximately USD 6 billion, equivalent to 8.7 percent of total exports in 2021. On average, 3.4 new export specializations were developed each year, a number that is slightly below the mean of the countries that belong to the lower-middle-income group.

Most new entries (42 over 54) were registered in the agricultural sector, accounting for USD 4.13 billion in 2021 (more than 2/3 of the export values of new entries). Only one significant export surge was registered in the electronics sector, *HS8544 Insulated electrical wire*, with a rapid export expansion between 2000 and 2005 and now accounting for more than USD 1.6 billion in exports. Entries in other sectors were relatively marginal.

The global demand for new Ukrainian specializations was particularly dynamic in the last few years, with an average of +26% between 2019 and 2021. This is encouraging with respect to the possibility of further strengthening Ukraine's international position in the global market.

The ability to defy the initial comparative advantage was relatively lower for the Ukrainian economy. The product relatedness to the pre-ex-

[5] Average products sophisticatedness – proxied by ProdY, i.e. the level of GDP per capita associated with each product's exports (Hausmann et al 2007) – weighted by the relative size of each product in the export basket. For Ukraine the weighted average is lower than a simple average as the weight of low-complexity goods in the export basket is high.

isting Ukrainian export basket measures to which extent the new entries were short jumps over the potential production space (i.e., high values of relatedness) or longer jumps (i.e., lower relatedness). The average 'proximity' or relatedness was equal to 0.48, a value higher than an average new entry in the world economy (0.46) and the average new entry experienced by Low-Middle-Income countries (0.45).

Qualitative analysis reveals interesting cases of successful diversification (ex., *HS0207 Poultry*, *HS0811 Fruits and Nuts* or wood products such as *HS4408, HS4418*). Still, expert opinions converge on the limited ability of the Ukrainian economy to deploy old and new capabilities toward emerging sectors. The most relevant bottlenecks mentioned by experts are inefficient credit markets, red tape and corruption, ineffective taxing system and political instability.

The Effects of the War on the Industrial Base and Capabilities

The ongoing war has substantially affected some of the strategic sectors on which the Ukrainian export basket is based, with extensive damages and a rather extensive relocation of some industrial plants toward regions less affected by the war. Still, expert opinions suggest that industrial capabilities have not been completely lost, and a certain degree of optimism on potential recovery prevails. Damages inflicted by the war on the competitiveness and specialization in minerals and metal sectors have been generally high as most of these industries are localized in areas affected mainly by the war and areas that are or have been under the temporary military control of the Russian Federation. The industrial recovery potential in most metal products will require a sizeable financial effort and a coherent mid-term strategy.

The damages to agricultural production are extensive due to the war, the intensive shelling and the disruption of logistic and transport infrastructures. However, the interviewees assessed the potential for a full recovery as high. The agriculture supply-side potential of 20 out of 25 regions of Ukraine did not change significantly.

Below, we report some highlights on the effects of the full-scale invasion of Ukraine in terms of 'lost specializations' and 'new emerging' ones, both considering evidence that emerged during UNIDO consultations and by analyzing export data for 2022.

Lost specializations and resilience

Some of the past specializations Ukraine acquired are 'suspended' and/or 'lost' due to the conflict. As the war is ongoing, assessing whether the status quo will be temporary or permanent is difficult. In the metal and chemical macro-sectors, important plants are currently damaged and not operational (ex., iron and steel, agricultural machinery, aviation, soda and glass production).

By comparing the export specializations emerging from the application of the DIVE tool and the export patterns in 2022 – the first full year affected by the conflict following the full-scale invasion of Ukraine – we have identified 33 lost HS4-digit specializations.[6] The most affected sectors are metals (9 lost specializations), agriculture (8 lost specializations) and chemicals (7 lost specializations). The export reduction in the affected product is remarkable and ranges from a minimum of -41% for *7215 Other bars and rods of iron or non-alloy steel* to the zeroing of exports in 2844 Uranium.

To have an overall picture of the destroyed specializations, it is sufficient to notice how the 33 products had an average RCA of 1.78 in 2021 that collapsed to 0.59 in 2022. In absolute terms, these lost specializations reached about 2.17 USD billion in 2021 and fell to 675 USD million after one year.

Although damages are severe, in the most affected areas of Ukraine, the 'core' of the production and resource base still exists or is largely redeployable with a coordinated effort and a strategic vision. Diversification policies in these territories might target products that are likely to have a high potential demand in the short-to-medium term and for which capabilities already exist (for

[6] These 33 products are those in the 2019-2021 export basket (according to the DIVE methodology) that have seen their RCA in Ukraine going from values above unity in 2021 to values lower than unity in 2022, according to UN Comtrade data.

instance, agricultural machinery, de-mining tools and vehicles, household appliances, household energy appliances, security and protection systems, building materials, etc.).

New emerging specializations and regional effects

New specializations emerged, such as the production of drones and components for them or other military equipment. These specializations are in Ukraine regions far from the war zone and have prospects for entering foreign markets.

By analyzing export data for the year 2022 and symmetrically assessing the lost specializations, we can identify new products for which Ukraine has an RCA>1. Among the 36 products, 24 recorded an increase in export values. Among the new specializations, most of which are agriculture products (11), metals (7), chemicals (6) and textiles (6), those with the highest export growth between 2021 and 2022 have been *1701 sugarcane and sucrose* (+596%), *1703 molasses* (+473%), *7227 bars of other alloy steel* (+373%), *9005 binoculars and telescopes* (+338%) and *5502 artificial filament tow* (+224.8%). The 36 new export specializations have experienced an increase in export volumes from 630 million USD to 813.5 million USD.

The leading regions in terms of volumes of industrial production sold in 2013 and 2022 were Dnipropetrovsk, Donetsk, Kharkiv and Zaporizhzhia regions and Kyiv city. According to the Index of industrial production, it is possible to identify three clusters to classify Ukrainian regions. These are:

- **Cluster I**. The regions that developed most dynamically and whose industrial production indices in 2021 were as high as in 2013. This cluster includes Vinnytsia, Zhytomyr, Odesa, Ternopil, Rivne, Lviv, Volyn, Mykolaiv, Kyiv, and Kherson regions.
- **Cluster II**. The regions that experienced a decline in industrial production indices lower or equal to 50% of initial industrial production. This cluster includes Ivano-Frankivsk, Kirovohrad, Zaporizhzhia, Poltava, Cherkasy, Khmelnytskyi, Sumy, Kharkiv, Chernivtsi, Dnipropetrovsk, Kyiv, Chernihiv, and Zakarpattia regions.
- **Cluster III**. The regions where the industrial production indices decreased by more than 50%. This cluster includes Donetsk and Luhansk regions, i.e., regions where military operations have been conducted since 2014.

Dnipropetrovsk, Donetsk, Kharkiv, Zaporizhzhia regions and the city of Kyiv represented the Ukrainian leaders in terms of industrial sales in both 2013 and 2021. During the same time frame, Vinnytsia, Zhytomyr, Odesa, Ternopil, Rivne, Lviv, Volyn, Mykolaiv, Kyiv, and Kherson regions have been the most dynamic in terms of industrial production indices. Among them, the performances of Odesa, Mykolaiv, and Kherson regions were due to the development of the agricultural sector and processing enterprises along with port infrastructure, while those of Vinnytsia, Zhytomyr, Ternopil, Rivne, Lviv, and Volyn regions originated by the development of new industries, such as woodworking and furniture production.

Industrial production in the Donetsk and Luhansk regions suffered the greatest decline due to the impact of the conflict in Eastern Ukraine and the destruction of the industrial output. These actions also hurt several regions in the second cluster (Zaporizhzhia, Poltava, Cherkasy, Sumy, Kharkiv, and Dnipropetrovsk regions).

Industrial and Export Capabilities of Ukraine and its Recent Evolution

In this section, the main goal is to assess the pre-war industrial and export specialization of the Ukrainian economy and the impact of the conflict on industrial capabilities. Any sound diversification policy should be based on the current production capabilities, the 'roots' on which new export specializations could realistically emerge in the post-conflict scenario. The analysis is based on disaggregated export data, which have the fundamental advantages of being widely available and more reliable than production data. At the same time, they are a reliable proxy of production baskets. The Ukrainian export basket—identified as the set of products with an RCA higher than unity for at least two years out of three—consists of approximately 200 products in the Harmonized System 4-digit nomenclature, characterized by an intermediate level of product sophisticatedness—a proxy for the level of productivity associated with the export of products—equal to USD 12,847[7]. Such value is below the world average (USD 15,064) but higher than that of lower-middle-income countries (USD 10,991).

The level of sophistication of Ukraine's export basket is attributable to its presence in the export basket of mineral, metals, and agriculture products with a relatively discrete level of product-specific sophisticatedness (ProdY). Table 1 reports Ukraine's top specializations – products with an average export value above 500 million USD in 2021 – representing 47 billion USD (approximately 68% of total exports). An inspection of the data reveals a concentration of the export basket in a few capital-intensive industrial sectors belonging to the metallurgical macro-sector – *2601 Iron ores and concentrated* with a share of almost 10% of total exports, *7207 Semifinished products of iron* (5.8% of total export), *7208 Flat-rolled iron, width >600mm, hot rolled, not clad* (5%), *7201 Pig Iron* (2.3%) and other metal products – and agricultural products – such as *1512 Sunflower seed oil* (9.2%), 1001 Wheat and meslin and 1005 Corn (both 8.5% of total exports). The industrial production base largely relies on resource and land abundance; export is mainly limited to primary products with no or limited capacity to sell high-value products in international markets. Only two products in the electronic industry enter the list of top specializations – *8544 Insulated electric wires* (1.6 billion USD of export in 2021, equal to 2.3% of total exports) and *8516 Electric heaters* (639 million USD). Limited space in the export basket is occupied by chemical products and machinery (one exception is *8411 Gas turbines*).

[7] Average products sophisticatedness – proxied by ProdY, i.e. the level of GDP per capita associated with each product's exports (Hausmann et al 2007) – weighted by the relative size of each product in the export basket. For Ukraine the weighted average is lower than a simple average as the weight of low-complexity goods in the export basket is high.

Table 1 | Most essential products in the Ukrainian export basket

HS code	HS description	Product sector	Exports in 2021 (million US$)	RCA - Balassa Index (2021)	ProdY (2017-19; US$)	Countries with product in EB (2019-21)	Low-Middle-Income countries with product in EB (2019-2021)	Nr. New Entries (period 1995-2021)	Nr. of New Entries in Low-Middle-Income countries (period 1995-2021)	% of Path-Dependent New Entries	Index of structural vulnerability	RCA War-Damage	Industrial Recovery Potential
2601	Iron ores and concentrates	Minerals	6,830	9.4	15,189	20	6	10	4	40	0.627	high	intermediate
1512	Sunflower seed oil	Agriculture	6,335	114.6	5,380	29	8	15	6	100	0.713	intermediate	high
1001	Wheat and meslin	Agriculture	5,870	28.9	15,631	22	1	8	2	100	0.463	intermediate	high
1005	Corn	Agriculture	5,857	34.1	8,869	22	5	12	4	50	0.661	intermediate	high
7207	Semifinished products of iron or non-alloy steel	Metals	4,082	29.4	10,307	26	6	19	3	44	0.734	high	intermediate-low
7208	Flat-rolled iron, width > 600mm, hot-rolled, not clad	Metals	3,549	14.7	16,756	24	4	2	0	100	0.476	high	intermediate-low
8544	Insulated electrical wire	Electronics	1,642	3.3	9,091	36	11	14	7	100	0.749	intermediate	intermediate-high
7201	Pig iron	Metals	1,607	68.4	6,528	9	2	4	1	40	0.472	high	intermediate-low
1205	Rape or colza seeds	Agriculture	1,367	29.5	16,233	20	2	5	0	100	0.374	intermediate	high
2306	Solid vegetable oil and fat residues	Agriculture	1,294	40.6	6,410	37	12	11	1	91	0.770	low	high
1003	Barley	Agriculture	1,175	33.7	16,421	20	1	6	1	33	0.512	low	high
7202	Ferroalloys	Metals	1,122	7.9	4,890	32	7	14	3	46	0.805	high	intermediate-low
207	Poultry	Agriculture	704	7.0	16,033	23	2	13	1	82	0.708	intermediate	high
4407	Wood sawn lengthwise	Agriculture	684	3.7	10,735	50	14	9	3	88	0.710	low	high
7213	Hot rolled bars of iron	Metals	676	10.8	11,232	34	9	10	4	63	0.641	high	intermediate
7304	Tubes, seamless, of iron or steel	Metals	668	9.4	16,745	25	1	10	1	83	0.546	high	intermediate
1201	Soya beans	Agriculture	668	2.6	9,121	15	3	7	2	25	0.505	intermediate	high
2818	Aluminum oxide	Chemicals	641	12.9	8,170	16	4	5	2	0	0.556	intermediate	intermediate-high
8516	Electric heaters	Electronics	639	2.8	18,824	24	3	4	1	100	0.378	low	high
7209	Flat-rolled iron, width > 600mm, cold-rolled, not clad	Metals	634	8.7	19,063	27	8	11	6	67	0.629	high	intermediate-low
3102	Nitrogenous fertilizers	Chemicals	633	5.3	13,330	41	10	14	6	90	0.734	intermediate	high
8411	Gas turbines	Machinery	513	1.2	24,997	15	2	8	1	40	0.628	intermediate	high

Data source: UNIDO elaboration, based on BACI, Centre d'Études Prospectives et d'Informations Internationales, World Development Indicators, World Bank, and UNIDO consultations with Ukrainian stakeholders.

Note: The products are ranked by export value (above 500 million USD) in 2021.

By examining product-level vulnerability and its weight in Ukraine's export basket, we can compute its vulnerability to external competition.[8] Given the large concentration of the export basket in the primary sector or related industries, the structural vulnerability of the Ukrainian export basket is lower than that of the average country in the world economy, with an average index of vulnerability of 0.67. In contrast, the world average equals 0.69 (38th percentile of the distribution). This is because the set of products Ukraine specializes in consists of goods with a relatively limited number of competing countries and high entry barriers. The products in which Ukraine is specialized with RCA[9]>1 are in the specialization pattern of about 26 countries while, worldwide, a product specialization is in the export basket of 19.24 countries (of which, on average, 5.78 are LMI). In 1995-2019, the recorded number of new entries (new competing countries) for an average Ukrainian specialization product was equal to 8.5 (on average, globally traded products have experienced 6.35 new entries, 1.7 in LMI countries).

Regarding Ukraine's specializations, Table 1 sheds light on the percentage of path-dependent new entries, i.e., how frequently a product signifies export diversification linked to existing capabilities.[10] Agricultural products representing Ukraine's primary export specializations have relatively high percentages of path dependence; in other words, it is unlikely that countries not specialized in related industries have developed a comparative advantage in these products. For instance, from 1995–2021, in all cases in which a country established a new specialization in "sunflower seed oil" or "wheat and meslin," this happened relatedly, meaning that the capabilities for developing the new specialization were based on existing ones. On the other hand, the share of path-dependent new entries is lower for most metallurgical products in Ukraine's export portfolio (*HS 2601; HS7207; HS7201*), for which pre-existing capabilities seem less relevant.

In sum, the Ukrainian export basket features a very high degree of concentration in two main macro sectors – agriculture and metals – but with a discrete level of diversification within these sectors. Agriculture products in which the country is highly specialized – see, for instance, the RCA Balassa indexes – present mixed levels of sophisticatedness; corn and sunflower seed oil and other vegetable oils, the most exported products in the pre-war period denote a low level of sophisticatedness. Different emerging specializations within the agricultural and agro-processing industries – for instance, *HS207 Poultry* and *HS1003 Barley* – are associated with higher levels of the ProdY index of sophisticatedness.

Except for rape or colza seeds, wheat and meslin and flat-rolled pig iron, the core products in Ukrainian export baskets are vulnerable to external competition. Based on the product-level Index of Structural Vulnerability (ISV), we can compute an aggregate measure that considers the relative importance of each specialization in the Ukrainian export basket. For the last available data, 2021, the Index of Structural Vulnerability (ISV) for Ukraine was 0.67 against a median value in the World economy of 0.69, placing the country in the 134th place in terms of vulnerability to external competition over a total of the 219 countries for which information on vulnerability in 2021 is available.

By considering the qualitative assessments derived from UNIDO consultations with Ukrainian stakeholders (hereafter UNIDO consultations), ICT emerges as a strategic sector for the Ukrainian economy. Exports in the ICT sector in 2021

[8] By following the DIVE tool methodology (https://www.unido.org/sites/default/files/files/2023-06/DIVE_Tool_Manual.pdf), we compute the country level of vulnerability as the weighted average of the product vulnerability of exported goods. Product specific vulnerabilities are computed on the basis of products' characteristics (ubiquity, frequency of new entry and tendency to enter in a path-departing way).

[9] Index for the Revealed Comparative Advantage, elaborated by Balassa (1965), computed as the ratio between a country's export share of a product and the worldwide export share of the same products. It indicates the degree of specialization of a country in such product.

[10] By following the DIVE tool methodology (https://www.unido.org/sites/default/files/files/2023-06/DIVE_Tool_Manual.pdf), we compute the relative occurence by which each product enters in countries export basket in a path-departing way, i.e., with a degree of relatedness to existing capabilities lower than the average potential new entry (option set, OS).

amounted to USD 12.6 billion and were highly diversified (Content Management System, Customer Relationship Management, software for large corporates and marketplace software for online sales and other online services; mobile applications for online banking, optimization of work processes in business and in the life activities of individual users; computer games, etc.). Export indicators reflect the industry's growth rate and the number of IT specialists increased from 244,000 in 2020 to 285,000 persons in 2021.

In the last two columns, qualitative information from UNIDO consultations is also reported in Table 1 concerning the assessment of war-related damage and industrial recovery potential. The ongoing war has substantially affected some of the strategic sectors on which the Ukrainian export basket is based. The qualitative assessments reported shall be interpreted with a grain of salt for two main reasons. Information on the extent of damages to industrial capacity is still limited, partly for national security reasons.[11] According to UNIDO Consultations with Ukrainian stakeholders (hereafter UNIDO consultations) and existing assessments (KSE 2023) suggest extensive damages and a rather extensive relocation of some industrial plants toward regions less affected by the war (about 70% of Kharkiv's industrial enterprises have been partially or entirely relocated). Still, expert opinions suggest that industrial capabilities have not been completely lost, and a certain degree of optimism on potential recovery prevails. Another reason for caution is related to the fact that the conflict – and its damages to Ukrainian industrial capacity both in terms of capital and human resources – is still ongoing.

The evaluation reported in Table 1 is based on publicly available information – for instance, operational stops or severe damages to major plants – and interviews with public officials or private companies. We use a quantitative scale for both variables. More precisely, we classify sectors into four groups based on their Revealed Comparative Advantage RCA war damage: i) none: no war-related damages specific to the sector are registered from expert consultations or other secondary sources. For sectors included in this category, damages are mostly limited to war-related economy-wide effects such as damages to transport infrastructures and logistic chains; ii) low: the conflict has generated some specific damages to the sector – for instance, limited reduction of productive agricultural land or episodic destruction of some productive facilities; iii) intermediate: the conflict has generated sizable loss of productive capacities in the sector – for instance important productive plants have been partly destroyed, damaged and/or production has been partially halted; iv) high: the conflict has generated significant disruption in production and severe damages to productive capacities – for instance significant destruction of essential productive plants.

Concerning the Industrial Recovery Potential indicator, we classify sectors employing the following three values: i) high: the potential for a full recovery of production capacity is very high as damages are limited and the disruption of production capacities is generally temporary and reversible; ii) intermediate: the potential for restoring the damaged productive capacities is high but essential financial and human resources are necessary as the sector has experienced a sizable amount of disruption due to the conflict; iii) low: the full recovery of the lost productive capacities is possible only with significant investments as the damages due to the conflict are sizable. Damages inflicted by the war on the competitiveness and specialization in minerals and metal sectors have been generally high as most of these industries are localized in areas primarily affected by the war or areas that are or have been under the temporary military control of the Russian Federation. For example, in 2021, the Mariupol Metallurgical Plant im. Ilicha and Azovstal provided 40% of steel production in Ukraine, and because of the war, these enterprises were primarily destroyed and ceased to produce. The industrial recovery potential in most metal products will require a sizeable financial effort and a coherent mid-term

[11] The Verkhovna Rada of Ukraine adopted the law *On Protection of the Interests of Entities Submitting Reports and Other Documents during Martial Law or State of War*, which determined that statistical and financial statements will be submitted by enterprises only after the war ceases.

strategy. The war is having a profound impact on both supply (direct damages, temporary military control of the Russian Federation, need to relocate in Western Ukraine, capital, and human losses, including migration and draft into Armed Forces; diversion of productive resources to the war effort) and demand (loss of market ties with Russia, Belarus, Iran; damages to logistic and transport infrastructures; higher trade costs).

The internal demand for metals – as well as for most building materials – is undoubtedly going to be very high due to the need to rebuild the damaged buildings and infrastructures, while the external demand might suffer in the short-term from the disruption of past market linkages and in the medium-term – from EU countries – from stricter environmental regulations. In three years (January 2026), the European Union will put into force the Carbon Border Adjustment Mechanism (CBAM) and require importers of certain carbon-intensive goods to pay for their products' embodied carbon emissions. The CBAM covers iron, steel, aluminum, cement, fertilizer, and electricity. According to the CBAM Exposure Index developed by the World Bank, this policy measure could significantly impact the competitiveness of Ukrainian exports to the EU. Ukraine presents the highest CBAM Exposure Index among countries exporting to the EU.[12] In the likely prospect of deeper integration of the Ukrainian economy into the EU, the reconstruction effort in these CO2-intensive sectors should consider stricter environmental regulations.

Although all sectors have been affected by the conflict, the damages to specific vital industries and productions reported in Table 1 are less severe. The damages to agricultural production are extensive due to the war, the intensive shelling, and the disruption of logistic and transport infrastructures. However, the interviewees assessed the potential for a full recovery as high. The agriculture supply-side potential of 20 out of 25 regions of Ukraine did not change significantly; for the regions that have been or still are most affected by the conflict, the main challenge will be that of unexploded ordinances and minefields.

Pre-war structural transformation: export surges in the period 1995-2021

In recent decades, the Ukrainian economy has experienced a profound structural transformation heavily conditioned by several political and socio-economic instability episodes. Part of the current export basket is rooted in specializations that predated the collapse of the USRR. Still, in the last decades, new specializations emerged due to the progressive integration of the country into the world economy. This section focuses on New Entries (NE), representing episodes of export surges or new specializations that progressively entered

[12] More information on the World Bank analysis on the vulnerability of exports to CBAM can be found here: https://www.worldbank.org/en/data/interactive/2023/06/15/relative-cbam-exposure-index#4

the Ukrainian export basket from 1995-2021.[13] The ability of a country to diversify its economy by adding new and more complex products to the export portfolio is a fundamental ingredient of structural change, socio-economic progress, and, ultimately, well-being. A focus on the number, importance, and features of export surges reveals a great deal of information on the dynamics of structural transformation and the ability of countries to defy their static comparative advantages.

The Ukrainian economy experienced export surges in 110 products. Still, those that entered in a stable and relevant way in the export basket – i.e., new specialization products – are the 54 products listed in Table 2. These new entries in the export basket accounted for approximately USD 6 billion, equivalent to 8.7 percent of total exports in 2021. On average, 3.4 new export specializations were developed each year, a number that is slightly below the mean of the countries that belong to the lower-middle-income group.

Most new entries (42 over 54) were registered in the agricultural sector, accounting for USD 4.13 billion in 2021 (more than 2/3 of the export values of new entries). Only one significant export surge was registered in the electronics sector, *HS8544 Insulated electrical wire*, with a rapid export expansion between 2000 and 2005 and now accounting for more than USD 1.6 billion in exports. Entries in other sectors were relatively marginal: textile (5 new products), chemical sector (2 new products), metals (2 new products), minerals, and machinery (1 new product each). Overall, the pattern of diversification involved products in a few sectors and was driven mainly by the land abundance of the country. Even the consolidated comparative advantage in metallurgical products did not lead to significant export surges in related and more complex goods in metal, machinery, and vehicle categories.

Besides the evidence gathered by adopting the UNIDO DIVE tool, further information on export surges is provided by UNIDO consultations. The growth in exports of *HS0409 Natural honey*, for instance, was possible mainly due to the introduction of cluster initiatives, which ensured cooperation in the export activities of many individual producers. As a result, Ukraine exported 61.2 thousand tons of honey worth $144.9 million in 2021. Thus, regarding product sales abroad, the country ranked fifth after China, India, Argentina, and Vietnam. Poland, Germany, Belgium, France, and Lithuania buy most Ukrainian honey.

Similarly, the cluster initiative has led to a success story in the export of *HS0802 Other nuts* (mostly walnuts). The cooperation of producers led to the inclusion of Ukraine among the top ten walnut exporting countries (USD 130 million in 2021), with 584 companies operating in Ukraine and supplying nuts to 82 foreign markets (65.8% to the EU). Another interesting diversification story is the rise in the export of fresh blueberries (*HS0810 Other fruits, fresh* and *HS0811 Fruits and nuts, frozen*). In 2022, the total export of fresh blueberries from Ukraine exceeded 2.5 thousand tons, increasing by 1.5 times compared to 2021. According to the top management of manufacturing Ukrainian companies interviewed during UNIDO consultations, ties with the Ukrainian diaspora in importing countries represented the critical factor for such export boost, and this evidence bears paramount significance in a post-conflict scenario in which the Ukrainian diaspora is expected to outstand. During this period, the wood processing industry also exhibited an export boom (some products listed in Table 2, such as *HS4408, HS4418, HS4401, HS441,1 and HS4404*). According to expert opinions, this success is related to several measures conceived to prevent market corruption and the adoption of a new regulatory environment.

[13] We focus on products for which we observe a rather rapid expansion of exports moving from an RCA<0.5 to an RCA>1 in time intervals of approximately 5 years that are then part of the Ukrainian export basket in a stable way until now (last year employed: 2021). We include only those products that are economically meaningful using as a threshold a minimum value of 1 million USD of export in 2021.

Table 2 | New Entries in the Ukrainian Export Basket in the period 1995-2021

HS code	HS description	Product sector	Exports in 2021 (million USD)	RCA - Balassa Index (2021)	ProdY (2017-2019; thousand USD)	Growth in global trade (%, 2019-21)	Countries with product in EB (2019-21)	Nr. New Entries (period 1995-2021)	% of Path-Dependent New Entries	Index of structural vulnerability	Prod. Relatedness with Ukrainian pre-existing EB
8544	Insulated electrical wire	Electronics	1,642	3.3	9.1	14.8	36	14	100%	0.76	0.61
0207	Poultry	Agriculture	704	7.0	16.0	8.6	23	13	92%	0.69	0.52
1201	Soya beans	Agriculture	668	2.6	9.1	41.6	15	7	43%	0.56	0.28
1507	Soybean oil	Agriculture	289	5.1	9.2	90.3	24	17	6%	0.81	0.40
4408	Sheets for veneering for plywood	Agriculture	281	17.9	8.5	31.2	37	7	100%	0.66	0.58
2304	Solid soybean residues	Agriculture	264	2.7	9.6	18.5	18	8	25%	0.65	0.48
4418	Wood carpentry for construction	Agriculture	251	4.1	18.1	28.7	36	9	100%	0.70	0.60
0811	Fruits and nuts, frozen	Agriculture	187	7.8	11.9	41.3	37	7	100%	0.66	0.64
2202	Waters, flavored or sweetened	Agriculture	130	1.5	12.7	23.2	60	20	100%	0.81	0.50
4401	Fuel wood	Agriculture	125	3.5	12.9	0.7	36	13	92%	0.76	0.41
4818	Toilet paper	Agriculture	122	1.3	14.5	0.4	42	10	100%	0.74	0.56
0802	Other nuts	Agriculture	118	1.8	5.7	0.7	36	10	70%	0.74	0.38
2403	Other manufactured tobacco	Agriculture	116	3.2	11.3	23.9	36	24	71%	0.81	0.43
1517	Margarine	Agriculture	83	3.1	15.4	44.9	36	19	79%	0.79	0.47
4421	Other articles of wood	Agriculture	80	2.7	13.5	31.8	23	7	100%	0.57	0.48
9404	Mattresses and bedding	Textiles	79	1.0	13.7	21.7	34	12	100%	0.74	0.53
7407	Copper bars, rods and profiles	Metals	76	3.2	17.9	36.3	27	10	70%	0.70	0.53
4402	Wood charcoal	Agriculture	74	14.8	5.2	10.1	27	10	50%	0.72	0.40
4411	Fiberboard of wood	Agriculture	73	1.7	21.2	27.7	32	13	100%	0.74	0.64
6304	Other furnishing articles	Textiles	62	3.9	4.8	15.9	27	16	94%	0.73	0.51
2303	Starch residues	Agriculture	60	2.9	16.7	20.1	20	7	57%	0.59	0.47
2002	Tomatoes, prepared or preserved	Agriculture	55	3.1	13.7	16.9	23	7	43%	0.62	0.52
0407	Eggs, in shell	Agriculture	50	3.2	14.0	12.3	38	12	92%	0.76	0.45
0405	Butter	Agriculture	45	1.2	32.2	14.2	21	11	91%	0.65	0.66
1101	Wheat or meslin flour	Agriculture	37	2.2	7.7	5.0	58	24	96%	0.82	0.49
1803	Cocoa paste	Agriculture	36	2.6	3.7	20.6	18	9	33%	0.67	0.36
0102	Bovine	Agriculture	32	1.0	8.0	1.4	45	18	89%	0.81	0.51
4301	Other raw furskins	Agriculture	29	5.8	38.8	26.1	15	2	0%	0.44	0.44
2102	Yeasts	Agriculture	26	2.8	13.1	13.4	35	6	100%	0.63	0.50
0404	Whey	Agriculture	23	1.2	29.7	29.7	23	9	100%	0.63	0.62

1107	Malt	Agriculture	23	1.7	19.9	7.1	21	8	75%	0.60	0.53
2923	Quaternary ammonium salts and hydroxides	Chemicals	20	2.2	24.7	19.6	15	4	75%	0.37	0.65
2529	Feldspar	Minerals	20	3.6	6.4	0.9	24	5	71%	0.56	0.49
1515	Other vegetable fats and oils	Agriculture	18	0.9	7.7	26.4	40	17	25%	0.65	0.36
0408	Egg yolks	Agriculture	16	4.0	25.6	5.4	20	7	71%	0.57	0.43
1204	Linseed	Agriculture	15	3.4	15.1	52.6	9	12	100%	0.71	0.49
2839	Silicates	Chemicals	14	5.2	13.8	19.9	20	7	100%	0.19	0.52
4205	Other articles of leather	Agriculture	14	1.5	14.3	2.6	25	13	0%	0.50	0.40
8401	Nuclear reactors and related equipment	Machinery	14	1.0	33.4	27.4	9	2	100%	0.44	0.60
4201	Saddlery and harnesses	Agriculture	14	1.4	15.8	66.0	18	2	33%	0.53	0.27
1501	Pig and poultry fat, rendered	Agriculture	14	3.7	31.3	106.9	18	5	0%	0.47	0.35
1007	Grain sorghum	Agriculture	14	1.2	5.1	260.7	9	6	38%	0.69	0.47
0505	Feathers and down	Agriculture	12	2.1	22.3	12.7	15	2	100%	0.74	0.57
4808	Corrugated paper and paperboard	Agriculture	10	1.2	14.9	19.3	31	14	0%	0.63	0.29
0909	Anise, fennel, etc.	Agriculture	7	1.5	1.3	25.5	20	3	100%	0.56	0.56
5606	Gimp yarn	Textiles	6	2.6	17.2	15.8	18	8	50%	0.37	0.42
8210	Hand-operated appliances, food preparation, <10kg	Metals	5	2.1	20.9	49.2	11	4	83%	0.58	0.50
4404	Strips and other pieces of wood	Agriculture	5	5.0	5.8	1.4	26	6	60%	0.74	0.43
5904	Linoleum	Textiles	5	4.3	24.9	2.3	8	4	75%	0.29	0.53
4822	Bobbins, spools, cops of paper	Agriculture	4	2.4	25.5	20.4	29	6	100%	0.59	0.60
6216	Gloves	Textiles	4	1.1	8.9	0.5	16	5	80%	0.45	0.28
2308	Vegetable materials for animal feeding	Agriculture	4	1.0	9.4	3.9	26	12	25%	0.76	0.40
1521	Vegetable waxes and beeswax	Agriculture	4	2.9	3.8	7.3	13	4	0%	0.53	0.32
1401	Vegetable materials used for plaiting	Agriculture	1	1.3	3.8	55.7	20	2	50%	0.43	0.52

Data source: UNIDO elaboration, based on BACI, Centre d'Études Prospectives et d'Informations Internationales and World Development Indicators, World Bank.

Note: Products are ranked by value of export in 2021; Products for which RCA>1 in 2021 and > USD 1 million USD.

It is interesting to notice that the level of product sophistication of the New Entries reported in Table 2 is overall lower than the weighted average of the export basket (weighted average PRODY in 2021 was respectively USD 11,922 for the new entries and USD 12,847 for the export basket). Although Ukraine has included several products with a significant degree of complexity, their weight in terms of export value is still limited. The bulk of exports are relatively unsophisticated goods, such as *HS8544 Insulated electrical wire* or *HS1201 Soybean products.*

The global demand for Ukrainian new specializations was particularly dynamic in the last few years, with, on average, +26% between 2019-2021, as reported at the bottom of Table 2. This is encouraging with respect to the possibility of further strengthening Ukraine's international position in the global market.

Table 2 reports additional information that allows us to assess Ukraine's competitive positioning in the new sectors of comparative advantage. The first two indicators are the number of countries with the same products in their current export basket and the number of countries that – like Ukraine – experienced an export surge in the considered time interval (1995-2021). For a proper benchmarking analysis, we also report the same indicators for countries with the same income group as Ukraine, the Low-Middle-Income (LMI) group, as defined by the World Bank's commonly used categories. On average, 26 countries have a revealed comparative advantage (RCA>1) in the products added to the Ukrainian export basket, of which six belong to the same income group of Ukraine. The corresponding average values for all the products of the HS trade classification (in total n. 1241) are 19.2 countries, of which 3.7 are from LMI countries. With respect to the new entries, on average, 9.4 countries entered the recent specializations developed by Ukraine and 3.4 from LMI countries. A useful benchmark is the average number of countries that acquire a new specialization in an average product (adopting the HS 4-digit classification) in the same period: 6.3 countries developed a new specialization; among these, 1.7 belong to the LMI group. These figures suggest that Ukraine entered new specializations with a relatively high number of competing countries. This result, which aligns with a relatively low level of sophisticatedness associated with these new entries, implies that entry barriers are not exceptionally high, and global markets for many of these products are highly contestable.

Table 2 reports the share of new entries experienced in the World economy for each path-dependent specialization product. A new entry is defined in the DIVE methodology as path-dependent when countries adding the product to their export basket already specialize in related products; in other words, production capabilities matter and are not easy for competing countries to acquire. In general, products with high path dependence are also characterized – mainly when the frequency of new entries' occurrence is high – by a relatively high Index of Structural Vulnerability (also reported in the Table).

The Index of Structural Vulnerability associated with the product in which Ukraine gained a comparative advantage (0.63) is slightly higher than the average computed using all products (n. 1241 of the HS 4 digits classification), which is equal to 0.61 but in line with other Low-Middle-Income countries (also 0.63).

The product relatedness to the pre-existing Ukrainian export basket measures to which extent the new entries were short jumps over the potential production space (i.e., high values of relatedness) or longer jumps (i.e., lower relatedness). The average 'proximity' or relatedness was equal to 0.48, a value higher than an average new entry in the World Economy (0.46) and an average new entry experienced by Low-Middle-Income countries (0.45); the ability to defy the initial comparative advantage was relatively lower for the Ukrainian economy.

To sum up, the analysis of the pre-war diversification pattern of Ukraine reveals the following stylized facts:

- Most of the new entries were related to agricultural products.
- The level of sophistication or complexity of the new entries in the export basket has been, on average, low (even lower than the overall export basket). Several high-complexity products are exported, but Ukraine shows a limited specialization in these goods and/or the export values are still limited. The current capabilities are relatively concentrated and conducive to specializations generally in low-income countries' export baskets.
- Ukraine developed new specializations in products that, on average, present many competing countries, as captured by the number of countries that include such specializations in their export baskets. This evidence is likely associated with relatively low entry barriers, high structural vulnerability and thus more contestable global markets.
- Qualitative analysis reveals interesting cases of successful diversification (ex., *HS0207 Poultry*, *HS0811 Fruits and Nuts* or wood products such as *HS4408, HS4418*). Still, expert opinions converge on the limited ability of the Ukrain-

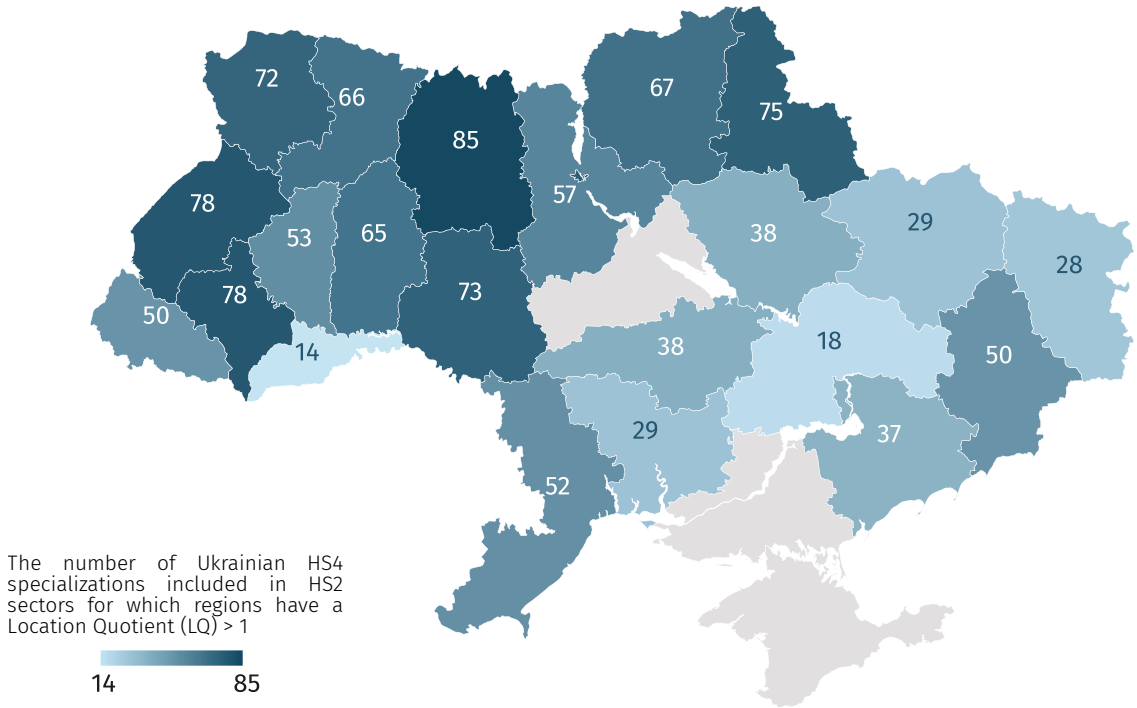
ian economy to deploy old and new capabilities toward emerging sectors. The most relevant bottlenecks mentioned by experts are inefficient credit markets, red tape and corruption, ineffective taxing system and political instability.

- Several cases of new entries of unrelated and path-departing products have been recorded along the time interval. Still, on average, Ukraine's ability to jump over the production space has been relatively more limited compared to an average country from the same income group.

The regional dimension of industrial capabilities

In this part, we shift the focus to regional specializations to highlight some features of the geographical dimension of the export basket and newly added products of comparative advantage. Figure 2 presents the geographical partitioning of the Ukrainian export basket by region. The figure reports the number of Ukrainian specialization products in which the regions have a location quotient – regional export share over national export share – larger than 1. We use the HS 2-digit trade classification, which allows regional data to be matched with national data. Darker colors are indicative of more diversified regional export baskets. A detailed analysis by region and sector (HS2-digits) is reported in Table 3.[14]

Figure 2 | Geographical distribution of Ukrainian export specializations, the average of 2017-2021



Data source: UNIDO elaboration, based on State Statistics Service of Ukraine and Centre d'Études Prospectives et d'Informations Internationales.

Note: The boundaries, names and designations on this map do not imply UNIDO's official endorsement or acceptance.

[14] To perform the Oblast-level analysis we adopt data for the pre-Covid period. The maximum level of disaggregation is provided at the 2-digit HS classification. Data availability is uneven among the territories. Taking into consideration data from 2019, disaggregated data is available for 24 territories (23 Oblasts and the Kyiv City), as data for Cherkasy region is only available at the HS Chapter level. Limited information is provided also for exports of Kherson region (13.5% of total), Kharkiv region (44.8% of total), Chernivtsi region (64.6%) and Kirovograd region (69.6%). Overall, in 2019, the available 2-digit export data cover 85.7% of aggregated figures.

Table 3 | Ukrainian export specializations by region and sector (year 2017-2021)

Products HS2-digits classification	Ukraine number of HS4-digits trade specialisation contained in HS2-digits	Number of regions with a relative specialisation (LQ>1)	Regions with a relative specialisation (LQ>1)
01 live animals	2	8	Chernihiv; Kirovograd; Kyiv city; Kyiv; Odesa; Rivne; Sumy; Ternopil.
02 meat and edible offal	1	5	Kyiv; Rivne; Ternopil; Vinnytsia; Volyn.
04 milk and dairy products, poultry eggs; natural honey	5	12	Chernihiv; Ivano-Frankivsk; Khmelnytsky; Kirovograd; Kyiv; Poltava; Rivne; Sumy; Ternopil; Vinnytsia; Volyn; Zhytomyr.
05 other products of animal origin	1	7	Lviv; Poltava; Rivne; Sumy; Ternopil; Vinnytsia; Volyn.
07 vegetables	2	7	Chernihiv; Khmelnytsky; Kyiv city; Odesa; Poltava; Rivne; Zaporizhzhya.
08 edible fruits and nuts	2	10	Chernivtsi; Khmelnytsky; Lviv; Odesa; Rivne; Ternopil; Transcarpathian; Vinnytsia; Volyn; Zhytomyr.
09 coffee, tea	1	6	Chernihiv; Kharkiv; Kyiv; Odesa; Rivne; Sumy.
10 cereals and grains	7	8	Chernihiv; Khmelnytsky; Kirovograd; Kyiv city; Mykolaiv; Odesa; Sumy; Vinnytsia.
11 products of the flour and cereal industry	5	4	Khmelnytsky; Kyiv city; Kyiv; Vinnytsia.
12 seeds and fruits of oil plants	8	11	Chernihiv; Khmelnytsky; Kyiv city; Kyiv; Mykolaiv; Odesa; Rivne; Sumy; Ternopil; Volyn; Zhytomyr.
14 plant materials for manufacturing	2	3	Kyiv city; Odesa; Vinnytsia.
15 Fats and oils of animal or vegetable origin	8	1	Transcarpathian.
17 sugar and sugar confectionery	2	8	Khmelnytsky; Kirovograd; Kyiv city; Kyiv; Lviv; Poltava; Sumy; Vinnytsia.
18 cocoa and cocoa products	2	3	Kyiv city; Kyiv; Sumy.
19 ready-made cereal products	2	7	Chernihiv; Khmelnytsky; Kyiv; Lviv; Poltava; Sumy; Vinnytsia.
20 processed vegetable products	2	7	Chernivtsi; Lviv; Mykolaiv; Odesa; Sumy; Ternopil; Vinnytsia.
21 miscellaneous food products	3	10	Khmelnytsky; Kirovograd; Kyiv city; Kyiv; Lviv; Rivne; Sumy; Vinnytsia; Volyn; Zhytomyr.
22 alcoholic and non-alcoholic beverages and vinegar	2	7	Kyiv city; Kyiv; Lviv; Mykolaiv; Odesa; Transcarpathian; Vinnytsia.
23 residues and waste from the food industry	5	6	Kirovograd; Kyiv city; Luhansk; Lviv; Odesa; Vinnytsia.
24 tobacco and industrial tobacco substitutes	2	4	Kyiv city; Kyiv; Lviv; Transcarpathian.
25 salt; sulphur; earth and stones	8	6	Donetsk; Ivano-Frankivsk; Khmelnytsky; Rivne; Vinnytsia; Zhytomyr.
26 ores, slag and ash	4	2	Dnipropetrovska oblast; Poltava.
27 mineral fuels; petroleum and its distillation products	3	6	Dnipropetrovska oblast; Donetsk; Ivano-Frankivsk; Kyiv city; Lviv; Poltava.
28 inorganic chemicals	8	2	Ivano-Frankivsk; Mykolaiv.
29 organic chemical compounds	3	7	Ivano-Frankivsk; Kirovograd; Luhansk; Odesa; Poltava; Transcarpathian; Vinnytsia.
31 fertilisers	1	4	Dnipropetrovska oblast; Kyiv city; Odesa; Poltava.
32 tanning extracts	1	2	Kyiv city; Sumy;
35 protein substances	1	8	Ivano-Frankivsk; Khmelnytsky; Luhansk; Mykolaiv; Ternopil; Vinnytsia; Volyn; Zaporizhzhya;
38 miscellaneous chemical products	2	5	Kyiv city; Kyiv; Luhansk; Vinnytsia; Zaporizhzhya.
39 plastics, polymeric materials	3	9	Chernihiv; Ivano-Frankivsk; Kharkiv; Khmelnytsky; Kyiv; Luhansk; Sumy; Ternopil; Volyn.
41 hides	1	5	Ivano-Frankivsk; Kyiv city; Lviv; Mykolaiv; Ternopil.
42 leather goods	2	5	Chernihiv; Kyiv; Lviv; Transcarpathian; Zhytomyr.

43 natural and artificial fur	1	3	Ivano-Frankivsk; Kyiv; Ternopil.
44 wood and wood products	15	11	Chernihiv; Ivano-Frankivsk; Kyiv; Lviv; Rivne; Sumy; Ternopil; Transcarpathian; Vinnytsia; Volyn; Zhytomyr.
48 paper and cardboard	6	7	Chernihiv; Ivano-Frankivsk; Kyiv; Luhansk; Lviv; Volyn; Zhytomyr.
49 printed matter	1	4	Kyiv city; Kyiv; Lviv; Sumy.
56 cotton wool	2	3	Chernihiv; Kharkiv; Poltava;
57 carpets	1	2	Khmelnytsky; Odesa.
58 special fabrics	1	6	Chernihiv; Ivano-Frankivsk; Lviv; Rivne; Transcarpathian; Vinnytsia.
59 textile materials	1	7	Kyiv city; Lviv; Poltava; Rivne; Ternopil; Transcarpathian; Volyn.
62 clothing and clothing accessories, textile	2	14	Chernihiv; Chernivtsi; Ivano-Frankivsk; Khmelnytsky; Kirovograd; Luhansk; Lviv; Poltava; Rivne; Ternopil; Transcarpathian; Vinnytsia; Volyn; Zhytomyr.
63 other finished textile products	2	5	Ivano-Frankivsk; Lviv; Rivne; Transcarpathian; Zhytomyr.
64 footwear	1	8	Chernihiv; Ivano-Frankivsk; Kyiv city; Lviv; Odesa; Sumy; Transcarpathian; Zhytomyr.
68 Articles of stone, plaster, cement	4	6	Ivano-Frankivsk; Kyiv; Luhansk; Lviv; Poltava; Zhytomyr.
69 ceramic products	3	5	Donetsk; Kharkiv; Khmelnytsky; Kyiv city; Zhytomyr.
70 glass and glassware	1	5	Kharkiv; Kyiv; Luhansk; Rivne; Zhytomyr.
72 ferrous metals	19	2	Donetsk; Zaporizhzhya.
73 products of ferrous metals	6	9	Chernihiv; Dnipropetrovska oblast; Donetsk; Kharkiv; Lviv; Odesa; Rivne; Sumy; Zhytomyr.
74 copper and copper products	1	3	Donetsk; Volyn; Zaporizhzhya.
78 lead and products of lead	1	1	Donetsk.
81 other non-precious metals	3	1	Zaporizhzhya.
82 tools, knife products	2	7	Chernihiv; Khmelnytsky; Kyiv; Lviv; Poltava; Rivne; Sumy.
83 other articles of non-precious metals	2	5	Lviv; Odesa; Sumy; Vinnytsia; Volyn.
84 nuclear reactors, boilers, machinery	9	8	Donetsk; Ivano-Frankivsk; Kharkiv; Kirovograd; Sumy; Volyn; Zaporizhzhya; Zhytomyr.
85 electrical machines	5	8	Chernivtsi; Ivano-Frankivsk; Khmelnytsky; Lviv; Ternopil; Transcarpathian; Volyn; Zhytomyr.
86 railway locomotives	4	4	Dnipropetrovska oblast; Odesa; Poltava; Volyn.
90 optical and photographic instruments and apparatus	1	7	Kharkiv; Khmelnytsky; Kyiv city; Kyiv; Luhansk; Odesa; Transcarpathian.
94 furniture	3	10	Chernivtsi; Kharkiv; Khmelnytsky; Kyiv; Lviv; Rivne; Ternopil; Transcarpathian; Volyn; Zhytomyr.
Total of HS4 sectors in the Export Basket	198		

Data source: UNIDO elaboration, based on State Statistics Service of Ukraine and Centre d'Études Prospectives et d'Informations Internationales.

The Harmonized System 2-digits trade classification, for which regional data are available, has a total of 58 products (listed in rows). For each region, we report the presence of a relative specialization in the HS2 products measured as the location quotient (LQ>1). In the second column, we report the number of HS4-digits products in which Ukraine specializes within the more aggregated HS2-digits category. These figures indicate the relative importance of each sector and the degree of within-sector diversification for the country. Within the agricultural sector, the entries HS10 Cereals and grains, *HS12 Seeds and fruits of oil plant* and *HS15 Fats and oils of animal and vegetable origin* present the highest number of HS4-digits products in the export basket (respectively 7, 8 and 8). *HS44 wood and wood products* also contain a relatively large set of country specializations (n. 15) and *HS72 Ferrous metals* (n. 19).

The information by column reveals the geographical distribution of each HS2-digits specialization. For instance, *HS72 Ferrous metals* – one of the most relevant sectors in the Ukrainian export basket, which has suffered the most from the

damages of the war, as discussed in this report – is primarily located in Donetsk and Zaporizhzhya. A highly geographically concentrated sector, as it is possible to see from the last column, reports the number of specialized regions by HS2-digit sectors.

While some (primarily agricultural) products are present in the export baskets of several regions (for example, *HS04 milk and dairy products, poultry eggs, natural honey*; *HS08 Edible fruits and nuts*; *HS12 Seeds and fruits of oil plants*; or *HS44 Wood and wood products* and *HS94 Furniture*), the industrial capabilities on which many Ukrainian specialization products are based are highly concentrated geographically.

For instance, *HS85 Electrical machine* (which includes *HS8544 Insulated electrical wires*, an essential product in the Ukrainian export basket) is present in 8 regions (Chernivtsi, Ivano-Frankivsk, Khmelnytsky, Lviv, Ternopil, Volyn, Zhytomyr and Transcarpathian), mainly in the West part of the country.

Another important sector, as discussed below, is *HS70 Glass and Glassware*; for this sector, there is a limited specialization by Ukraine (only 1 HS4-digits product), and production capacities are primarily present in 5 regions (Kharkiv, Kyiv, Luhansk, Rivne and Zhytomyr), some of them highly impacted by the conflict.

As for 2021, i.e., the pre-war diversification pattern of Ukraine, Kyiv, Lviv and Western regions presented a relatively higher level of cross-sectoral diversification. On the contrary, some regions are characterized by a more concentrated export basket, such as Chernivtsi and Dnipropetrovska oblast (n. 5 HS2-digits sectors), Mikolaiv and Zaporizhzhya (n. 7 HS2-digits sectors). These initial considerations are instrumental for the analysis that is reported in the rest of this report, in particular for assessing how the war is impacting regional capabilities and specializations (Section 3) or how the diversification targets identified using the DIVE tool (Section 5) might leverage on existing localized capabilities.

The Effects of the War on the Industrial Base and Capabilities

The ongoing conflict has already significantly affected Ukraine's industrial potential and capabilities. Ukraine had a revealed comparative advantage in approximately 210 products before the conflict broke out (UN Comtrade Database). In 2022, while losing a comparative advantage in 47 products, Ukraine gained an advantage in 35 products, with 25 showing increased exports. Among the 163 products where Ukraine maintained a comparative advantage, 42 saw increased exports, indicating that the country has a reservoir of skills and capabilities, as discussed in UNIDO's Ukraine: Industrial Diagnostic Study (2024). The economy's supply side has been affected by direct capital and human losses and indirect effects such as higher trade and operational costs, which limit competitiveness. The Kyiv School of Economics regularly provides an extensive analysis of the damages to production facilities and infrastructure.[15] The demand side is affected by severed economic relations with Russia, Belarus, and third countries, for which trade costs have exploded and diverted their imports and exports toward other destinations.

Already, the non-recognized annexation of Crimea and the conflict in Eastern Ukraine had a significant impact on the industrial development of Ukraine and its regions. In 2013, the sales volume of Ukrainian goods abroad amounted to $63.3 billion. However, exports fell by 13.5% in 2014 and 29.3% in 2015. The decline in industrial development was not only due to the loss of some critical enterprises (for example, Donetsk Metallurgical Plant, O. F. Zasiadko Mine, Luhansk Pipe Plant, and Luhansk Cartridge Plant) but also due to a decrease in trade between Ukraine and the Russian Federation, which was a key importer of Ukrainian products. The declining sectors since 2014 included chemicals, machine-building, stone, textiles, and transport means. Somewhat emblematic was, in fact, the loss of specialization sectors such as parts of railways; the export value of *HS8606 Railway cars, not self-propelled* in 2012 was equal to 2.9 billion USD and in general, vehicles and parts accounted for approximately 6 billion USD (in 2021, the overall export value of this macro-sector is 0,8 billion USD).

Below, we discuss the effects of the full-scale invasion of Ukraine in terms of 'lost specializations' and 'new emerging' ones, considering evidence that emerged during UNIDO consultations and analyzing export data for 2022.

Lost specializations

Some specializations highlighted above are 'suspended' and/or 'lost' due to the conflict. As the war is ongoing, assessing whether the status quo will be temporary or permanent is difficult. Many strategic enterprises and production plants are located in areas that are or have been under the temporary military control of the Russian Federation. UNIDO consultations highlighted how essential plants in the metal macro-sectors, such as the

[15] KSE Institute (2023), Report on Damages to Infrastructure Caused by Russia's War against Ukraine, March 2022. Available at: https://kse.ua/wp-content/uploads/2023/03/ENG_FINAL_Damages-Report_.pdf

Ilyich Iron and Steel Works of Mariupol[16], Azovstal Iron and Steel Works, Alchevsk Iron and Steel Works, Makiivka Iron and Steel Works, Yenakiieve Iron and Steel Works, Torez hard metal surfacing plant are currently damaged and not operational. Many enterprises from other strategically important areas of activity are in similar conditions: the chemical manufacturer Concern Stirol, the Rubizhne State Chemical Plant Zoria, the pulp and paper industry enterprise Rubizhne Cardboard and Packaging Mill, the enterprise for the manufacture of agricultural machinery for harvesting grain and leguminous crops the Berdiansk Harvesters, the Melitopol Plant of Automobile and Tractor Spare Parts, as well as several other production facilities such as the State Aircraft Manufacturing Company Antonov in Kyiv[17] are currently damaged and not operational.

At the same time, even though more than 20% of arable land is in the areas that are or have been under the temporary military control of the Russian Federation, the agriculture macro-sector maintained its leading position in Ukraine's industrial production and export. This sector is proving highly resilient and suggests a high possibility for a full recovery.

A notable example of the disruption caused by the full-scale invasion of Ukraine – starting with the non-recognized annexation of Crimea - is the production of soda in Ukraine. Until 2014, there were three soda plants in Ukraine: Sloviansk, Lysychansk and Krasnoperekopsk (Crimea). Soda plants in Sloviansk and Lysychansk stopped working in 2010. At the same time, PJSC Crimean Soda Plant represented about 80% of the Ukrainian soda ash market and more than 2% of the respective world market. After the non-recognized annexation of Crimea in 2014, Ukraine became completely dependent on the import of soda ash and baking soda. This is a strategic issue for Ukraine's reconstruction efforts since soda is used to produce glass, several building materials, and some other products. In 2014, CJSC Lysychansk Glass Factory Proletarii was partially destroyed due to hostilities and then lost, thus leading to the cessation of flat glass production in Ukraine, which was never restored.

Also, the production capacity in several metallurgical enterprises in Eastern Ukraine or in other regions that are or have been under the temporary military control of the Russian Federation was lost, which, in turn, led to a sharp reduction in production and exports in the Ukrainian machine-building sector.[18]

Although damages are severe, in the most affected areas of Ukraine, the 'core' of the production and resource base still exists or is largely redeployable with a coordinated effort and a strategic vision. Diversification policies in these territories might target products that are likely to have a high potential demand in the short-to-medium term and for which capabilities already exist (for instance, agricultural machinery, de-mining tools and vehicles, household appliances, household energy appliances, security and protection systems, building materials, etc.).

However, tackling industrial recovery and spatial inequalities in border regions will be possible only when the conflict ends. Uncertainty about the future for businesses in the most affected regions is neutralizing even the current support efforts. According to the Ministry of Economy, businesses in these regions have not been very active in applying for development grants offered under emergency support schemes; this is likely due to prevailing uncertainties on the future of these re-

[16] The company had the capacity to annually produce 3.7 million tons of converter steel, 12 million tons of sinter, more than 4.3 million tons of cast iron and more than 5 million tons of finished rolling mill products. The plant was an important Ukrainian exporter. The company was also the largest manufacturer of galvanized cold-rolled sheets in Ukraine, which was used in construction and the automotive industry.

[17] *Antonov* plant was one of the two enterprises of the Ukrainian aircraft industry, employing more than 9 thousand workers. The world's largest cargo aircraft AN-225 (*Mriya*) was built here. The plant had a full cycle of aircraft development: from research at the stage of project creation to construction and testing, produced both cargo (AN-132, AN-138) and passenger aircraft. The production facilities were partly damaged in March 2022.

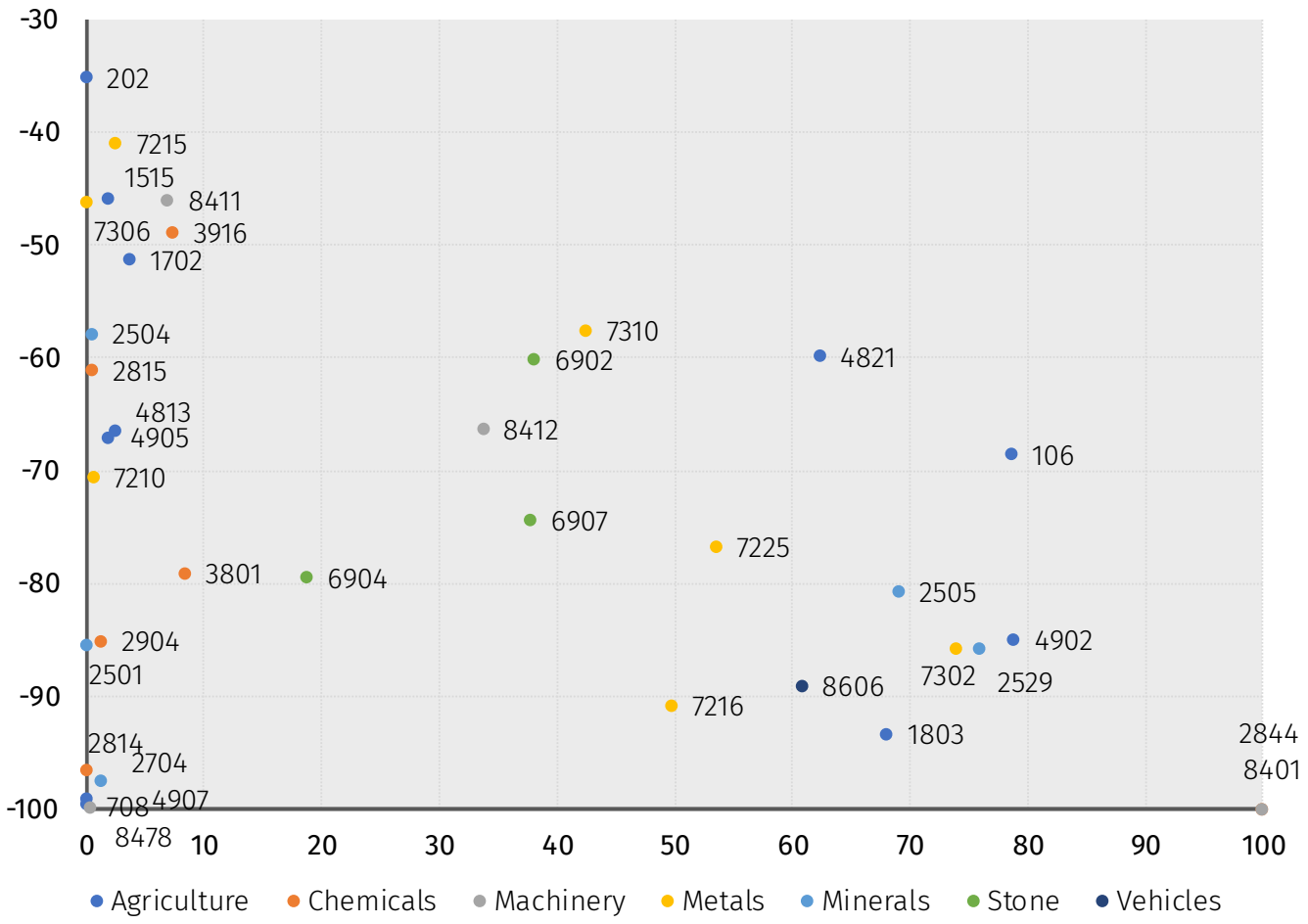
[18] PJSC Alchevsk Iron and Steel Works, Yenakiyeve Iron and Steel Works, Donetsksteel metallurgical plant, PJSC Khartsyzsk PIPE PLANT are located in the areas that are or have been under the temporary military control of the Russian Federation. Two large mining and metallurgical plants were largely destroyed – Azovstal iron & steel works and PJSC Ilyich Iron and Steel Works.

gions and is a worrying signal of the need to provide a credible and clear strategy for economic recovery.

By comparing the export specializations emerging from the application of the DIVE tool and the export patterns in 2022 – the first full year affected by the conflict following the full-scale invasion of Ukraine – we have identified 33 lost HS4-digit specializations.[19] The most affected sectors are metals (9 lost specializations), agriculture (8 lost specializations) and chemicals (7 lost specializations). The export reduction in the affected product is remarkable and ranges from a minimum of -41% for *7215 Other bars and rods of iron or non-alloy steel* to the zeroing of exports in *2844 Uranium*. As for the case of uranium, the analysis of past commercial ties allows us to understand that the main reason behind the sudden contraction in exports for some former specializations is that Russia used to represent the leading partner country. Indeed, specializations such as uranium exports or *8401 nuclear reactors and related equipment* disappeared in 2022 because the Russian Federation used to be the destination of 99.95% and 100% of Ukrainian exports in 2021.

Figure 3 reports the information on the 33 lost specializations with respect to the magnitude of trade reduction and the share of exports to Russia before the invasion. Such a figure allows us to visually distinguish between lost specializations

Figure 3 | Weight of Russia as a trading partner before the invasion and export reduction of lost specialization in 2022.



Data source: UN Comtrade, UN.

Note: Lost specialization products were in Ukraine's export basket in 2019-2021, for which UN Comtrade data shows the existence of an RCA>1 in 2021 and an RCA<1 in 2022.

[19] These 33 products are those in the 2019-2021 export basket (according to the DIVE methodology) that have seen their RCA in Ukraine going from values above unity in 2021 to values lower than unity in 2022, according to UN Comtrade data.

probably linked to the destruction of production capabilities and those deriving from the zeroing of commercial interaction with the Russian Federations that will likely be restored after replacing Russia with new partner countries.

Chemical products such as *2815 Sodium hydroxide* (-61%), *2814 Ammonia* (-96.5%), *3801 Artificial graphite* (-79%), *2904 Sulfonated, nitrated derivatives of hydrocarbons* (-85%), *2901 Acyclic hydrocarbons* (-74.7%) and *3916 Monofilament* (-48.8%) have experienced a substantial reduction in exports reflecting destruction in capabilities since such specializations had a relatively low share of production addressed to Russia. *0708 Legumes* have seen their exports decrease by 99.46% despite not representing an export product for Russia before the war. On the contrary, agricultural products such as *0106 Other live animals*, *1803 Cocoa paste*, and *4821 Paper labels* have also exited the Ukrainian export basket (or mainly) because of the role of the Russian Federation as a trading partners in the pre-war period. Such export specialization destruction might be recovered once the country identifies new partners to divert pre-war trade patterns.

The only electronics lost specialization – *8606 railway cars, not self-propelled* – has been hit by the destruction of export ties with the leading trade partner, i.e., Russia (export share 60.8% in 2021) since the export volume has decreased by 76.7 % between 2021 and 2022.

To have an overall picture of the destroyed specializations, it is sufficient to notice how the 33 products had an average RCA of 1.78 in 2021 that collapsed to 0.59 in 2022. In absolute terms, these lost specializations reached about 2.17 USD billion in 2021 and fell to 675 USD million after one year.

New emerging specializations

According to UNIDO consultations, the war effort has generated a significant shift of resources in new sectors. New specializations emerged, such as the production of drones and components for them or other military equipment. These specializations are primarily located in regions of Ukraine far from the war zone. According to expert opinions, these new industries have prospects for entering foreign markets. Expert opinions acquired for the drafting of this report suggest that the "prospects for entering foreign markets of innovative products of the Ukrainian military-industrial complex are very high – for this purpose, in June 2023, the State Company Ukroboronprom was reorganized into the Joint Stock Company Ukrainian Defense Industry.

New enterprises started their operations to meet the needs of Ukraine's Armed Forces in the country's Western regions. Another important finding that emerged from interviews is the creation of new enterprises in regions receiving residents moving from the Eastern regions of Ukraine. Official statistics do not yet allow us to assess the features and size of the changes in production composition. Still, the sectors affected by this shift of human and financial resources are agriculture, food industry, IT, light industry (primarily textiles), and medical supplies.

By analyzing export data for the year 2022 and symmetrically assessing the lost specializations, we can identify new products for which Ukraine has an RCA>1.[20] Of the 36 products, 24 recorded an increase in export values. Most of these products are characterized by low export share addressed to Russia in 2021, except for 6310 Used or new rags textile scrap, for which Ukraine has experienced a change in the target market, with the share of exports headed to Russia falling from 50% in 2021 to 5.6% in 2022.

The new specializations with the highest RCA in 2022 are *3822 Diagnostic or laboratory reagents* (RCA equal to 73), *6501 hat forms* (7.8), *1703 Molasses* (4.25), *2618 Granulated iron or steel slag* (3.87) and *3606 Ferrocerium and other pyrophoric alloys* (3.17). Among the new specializations, most of which are agriculture products (11), metals (7),

[20] To compare new export patterns with pre-war specializations, we have identified a list of products that were not part of the export basket, that have an RCA>1 in 2022, that show an average export value of at least 1 USD million in the period 2021-2022.

chemicals (6) and textiles (6), those with the highest export growth between 2021 and 2022 have been *1701 sugarcane and sucrose* (+596%), *1703 molasses* (+473%), *7227 bars of other alloy steel* (+373%), *9005 binoculars and telescopes* (+338%) and *5502 artificial filament tow* (+224.8%). The 36 new export specializations raised after the change in capabilities derived from the full-scale invasion of Ukraine have experienced an increase in export volumes from 630 million USD to 813.5 million USD.

The comparison between the products exported with revealed comparative advantage in 2021 and those exported in 2022 highlights how, despite the loss of several specializations - mainly due to the loss of trading opportunities with Russia, which used to represent Ukraine's leading partner – the Ukrainian industrial structure shows a discrete degree of resilience, also in the first year of conflict, before the start of most post-conflict recovery plans aiming also in promoting the integration with the EU. In such light, the diversification strategies – reported in the next section – also aim to consider the degree of complementarity between potential new specializations and import demand by European economies.

Extending the time span of the analysis: the effects of a prolonged conflict on country and region industrial production

This section analyzes Ukraine's industrial production and export performance in 2013-2022 by considering the recent full-scale war derived from the full-scale invasion of Ukraine. These other two external shocks have hit Ukraine. These are the non-recognized annexation of Crimea, the conflict in Eastern Ukraine, and the global COVID-19 pandemic, which spread to Ukraine in the period 2020-2021 (see also Khaustova et al., 2024).

By following a multi-stage approach in which the analysis of the dynamics of industrial production indices and the export dynamics encompasses i) the analysis of the structure of industrial production by type of economic activity and the clustering of economic activities by the production development dynamics, ii) the analysis of the structure and dynamics of exports by commodity groups, iii) the analysis if the impact of the non-recognized annexation of Crimea and the conflict in Eastern Ukraine and iv) the identification of Ukrainian regions' production specializations, we provide insightful details of the impact of the external shocks on the past decade.

Industrial production in Ukraine almost halved from 2013-2021 (in 2021, it amounted to 52.4% of 2013's level). Exports dynamics over the same period have experienced a decrease, and in 2021, export value reached 70.3% of the level in 2013.

The leading regions in terms of volumes of industrial production sold in 2013 and 2022 were Dnipropetrovsk, Donetsk, Kharkiv and Zaporizhzhia regions and the city of Kyiv. Over the time interval under scrutiny, the share of industrial production relative to the Luhansk region – the largest among the Ukrainian regions – has decreased by 4.7%. In comparison, the share of the Kyiv region has reduced by 2.3%. From 2013 to 2021, the share of the Dnipropetrovsk region has increased by 2.6%, as well as the industrial production in Kharkiv, Zaporizhzhia and Poltava regions (by 0.6%, 2.6% and 1.4%, respectively). The most dynamic growth in the industrial production indices in 2021 compared to 2013 was in the regions of Vinnytsia (+135.4%), Zhytomyr (+131.0%), Odesa (+125.5%), Ternopil (+119.6%) and Rivne (+119.9%).

According to the Index of industrial production, it is possible to identify three clusters to classify Ukrainian regions. These are:

- **Cluster I**. The regions that developed most dynamically and whose industrial production indices in 2021 were as high as in 2013. This cluster includes Vinnytsia, Zhytomyr, Odesa, Ternopil, Rivne, Lviv, Volyn, Mykolaiv, Kyiv, and Kherson regions.
- **Cluster II**. The regions that experienced a decline in industrial production indices lower or equal to 50% of initial industrial production. This cluster includes Ivano-Frankivsk, Kirovohrad, Zaporizhzhia, Poltava, Cherkasy,

Khmelnytskyi, Sumy, Kharkiv, Chernivtsi, Dnipropetrovsk, Kyiv, Chernihiv, and Zakarpattia regions.

- **Cluster III**. The regions where the industrial production indices decreased by more than 50%. This cluster includes Donetsk and Luhansk regions, i.e., regions where military operations have been conducted since 2014.

In virtue of the industrial production dynamics illustrated, Dnipropetrovsk, Donetsk, Kharkiv, Zaporizhzhia regions and the city of Kyiv represented the Ukrainian leaders regarding industrial sales in both 2013 and 2021. During the same time frame, Vinnytsia, Zhytomyr, Odesa, Ternopil, Rivne, Lviv, Volyn, Mykolaiv, Kyiv, and Kherson regions have been the most dynamic in terms of industrial production indices. Among them, the performances of Odesa, Mykolaiv, and Kherson regions were due to the development of the agricultural sector and processing enterprises along with port infrastructure, while those of Vinnytsia, Zhytomyr, Ternopil, Rivne, Lviv, and Volyn regions originated by the development of new industries, such as woodworking and furniture production.

Industrial production in the Donetsk and Luhansk regions suffered the greatest decline due to the impact of the conflict in Eastern Ukraine and the destruction of the industrial output. These actions also hurt several regions in the second cluster (Zaporizhzhia, Poltava, Cherkasy, Sumy, Kharkiv, and Dnipropetrovsk regions).

In terms of exports of industrial goods, the leading commodity groups exported from Ukraine in 2022 were: cereals (10) – 20,6% (share in the country's total exports); ferrous metals (72) – 10,3%; ores, slag, and ashes (26) – 7,0%; animal or plant fats and oils (15) – 7,0%. Compared to 2013, the share of exports of ferrous metals (72) decreased by 12.7%, but the share of exports of cereals (10) increased by 10.4%. The most dynamically growing exports during this period were oil seeds and fruits (12) - by 183.9%, animal or plant fats and oils (15) - by 170.1%, and cereals (10) - by 143.4%.

According to the dynamics of exports, the commodity groups exported by Ukraine can be classified into four different clusters:

- **Cluster I**. The most dynamic commodity groups for which exports increased from 2013-2022. This cluster includes live animals (01), meat and meat preparations (02), eatable fruits and nuts (08), cereals (10), oil seeds and fruits (12), animal or plant fats and oils (15), remains and wastes of food industry (23), wood and articles of wood (44), glass and preparations thereof (70) and furniture (94).
- **Cluster II**. The commodity groups for which exports have declined by no more than 50%. This cluster of commodities involves milk and milk products, eggs, honey (04), alcoholic and non-alcoholic beverages, vinegar (22), ores, slag, and ashes (26), organic chemical combinations (29), pharmaceutical products (30), knitted clothes and knitted articles of clothes, textile clothes and textile articles of clothes (61-62) and electric machines (85).
- **Cluster III**. The commodity groups experienced a decrease in export volumes between 50 and 75% with respect to the values in 2013. Among these, we find cocoa and cocoa preparations (18), tobacco and industrial substitutes of tobacco (24), ferrous metals (72), preparations from ferrous metals (73), nuclear reactors, boilers, machines (84) and ground transport facilities excluding railway (87).
- **Cluster IV**. The commodity groups whose exports have declined by more than 75% include inorganic chemicals (28), fertilizers (31), paper, paperboard (48), ceramic products (69), railway locomotives (86) and aircrafts (88).

According to this classification and considering the clusters with the largest export shares, the most dynamic products result in cereals (10), animal or plant fats and oils (15), oil seeds and fruits (12), as well as live animals (01), meat and meat preparations (02), eatable fruits and nuts (08), remains and wastes of food industry (23), wood and articles of wood (44), glass and preparations thereof (70) and furniture (94).

In 2022, the exports of almost all product groups declined yearly, except for only oil seeds and fruits (12), meat and meat preparations (02), milk and milk products, eggs and honey (04). In 2022,

the leading exporting regions of Ukraine were the city of Kyiv, Dnipropetrovsk, Lviv, Zaporizhzhia, and Odesa regions. In 2013, in addition to the regions mentioned above, the Donetsk region accounted for the largest share of the country's export volumes (19.6%), but in 2022, its share in exports decreased to 0.6%. In the period, the most dynamic regions have been Vinnytsia (+235.6%), Lviv (+234.4%), Chernivtsi (+228.8%), and Ternopil region (+213.7%).

Four clusters are also identified to classify regions according to the dynamics of commodity exports in 2013-2022.

- **Cluster I**. The regions that led the way in export growth more than doubled between 2013 and 2022. The Ukrainian regions are Vinnytsia, Lviv, Chernivtsi, and Ternopil.
- **Cluster II**. The regions with dynamic exports grew by a rate between 100 to 200%. The regions of this cluster include Volyn, Cherkasy, Khmelnytskyi, Rivne, Zakarpattia, Odesa, Ivano-Frankivsk, Chernihiv, Zhytomyr, Kyiv, and Kirovohrad regions.
- **Cluster III**. The regions with declining exports by less than 50 %. This cluster includes the cities of Kyiv, Sumy, Zaporizhzhia, Mykolaiv, Poltava, and Dnipropetrovsk regions.
- **Cluster IV**. The regions with over 50 % declining exports include Kharkiv, Kherson, Donetsk, and Luhansk.

The analysis of the decade from 2013 to 2022 allowed us to highlight the structural changes in Ukrainian regions. Except for the Donetsk region, the most export-oriented regions in 2022 and 2013 were the same (the city of Kyiv, Dnipropetrovsk, Lviv, Zaporizhzhia, and Odesa regions). However, among them, only the Lviv and Odesa regions have been developing dynamically all along, while the rest had positive development dynamics until 2022, and in 2022, experienced a significant reduction in exports (from 48.6 to 31.7%). The largest decline in exports in 2022 occurred in Luhansk, Donetsk, Kherson, Mykolaiv, and Kharkiv regions, i.e., the border regions that suffered great destruction due to the full-scale invasion of Ukraine.

Industrial Recovery and Diversification Strategies for Ukraine

This section aims to contribute to the analytical base on which the 'way forward' for industrial reconstruction and development in Ukraine will be based. Based on the analysis presented in the following sections, we present lists of four different target products that Ukraine could prioritize in its twofold effort to promote and prioritize the reconstruction of critical industrial capabilities and the diversification of the export basket.

The DIVE tool is applied in the standard way but re-adapted to consider two fundamental elements. The full-scale invasion of Ukraine has severely damaged industrial capabilities and altered, often in an intense way, the pre-war comparative advantage of the country. This consideration means that diversification strategies must necessarily 'look backward' and embed a strategic but realistic effort to reconstruct what was damaged or lost in the conflict. The second consideration is that future industrial development strategy will happen in a new geopolitical space where Ukraine will likely boost its socioeconomic integration with the EU while severing or reducing interactions on its North and West borders.

Four clusters of target products

Set 1: Short jumps with a high path dependence and many competitors

These products belong to Ukraine's potential diversification space and have a high degree of path dependence, i.e., products for which an economy's initial capabilities matter for the acquisition of a new specialization and which are characterized by a high degree of proximity (or relatedness) with the country's current export basket. In other words, these are targets that, in a coordinated effort of industrial recovery (post-conflict reconstruction) and diversification, have the highest level of feasibility for the Ukrainian economy (i.e., lower risks related to missing productive capabilities). In the selection exercise, we employ three criteria that enhance the targets' strategic value. The first is a significative relatedness gain (or advantage), i.e., a condition that ensures that the product is more closely related to Ukraine's export basket than other countries with a similar level of development (lower middle-income countries). As a second criterion, we employ the presence of a positive complexity gain, or in other words, the inclusion of target products that have the potential to enhance the average degree of complexity or sophisticatedness of the Ukrainian economy. Based on these criteria, we give more importance to relatively more knowledge- or capital-intensive goods at the expense of products that – although 'close' to the pre-war comparative advantage of Ukraine – are now probably less strategic and desirable (for instance, products belonging to the textile or agriculture macro-categories associated with a relatively low value-added and sophisticatedness). The third criterion – relaxed for the definition of set 2 below - is the presence of many countries that already specialize in the given product. This latter criterion shall be interpreted simultaneously as indirect evidence of relatively low entry barriers for acquiring a trade specialization and potentially higher vulnerability to competitive pressures from other countries.

This first target list comprises 60 products from a wide range of sectors. Given their proximity with the current set of products exported by Ukraine (see third to last column in Table 4), these products are feasible targets, and Ukraine possesses a significative relatedness advantage (second to last column) with respect to competing countries in the same income group). For instance, *HS8433 Harvesting or agricultural machines* – a product that might be highly interesting as an option for diversification given high internal and foreign demand and the presence of essential production capabilities - has a proximity with the current export basket (0.663) and on average this proximity

is larger by 0.204 compared to other LMI countries. The table contains other vital features of the target products that might inform policy directions. Using the example of *HS8433* again, the associated complexity gain with respect to the current Ukrainian export basket is high +10.1 thousand USD; the recent dynamics of global trade in this product was high (+29.4% in the period 2019-2021) and, even more importantly, the product presents a very high potential partners' import penetration index – which combines the size of imports from likely importing countries with their distances from Ukraine in km – in particular toward the EU markets. The number of competitors in these sectors is generally high but not necessarily from other LMI countries. The number of times the product enters the export baskets in the rest of the world (period 1995-2021) is a proxy for entry barriers, and countries targeting a specific product might learn – in a second stage of the targeting exercise – from past experiences of other countries that successfully managed to develop a comparative advantage in the sectors.

We do not provide a comprehensive evaluation of the products in the table. Still, we underline that a sizable number of these potential specializations are likely to produce outputs that will be in high demand during the post-war reconstruction effort (ex. *4009 Vulcanized rubber tubes*, *8405 Water gas generators*, *6810 Articles of cement, of concrete or artificial stone*, *9406 Prefabricated buildings*, *8501 Electric motors and generators*, 3006 *Pharmaceutical goods*, *9021 Orthopedic appliances*). It is worth noticing how the product 9406 Prefabricated buildings are among the new specializations according to export data provided by UN Comtrade, despite a slight decrease in the absolute value of exports.

In the light of deeper trade links with EU countries, some products show a high export potential: *7604 Aluminum bars*, *7212 Flat-rolled iron, width < 600mm, clad*, *4005 Compounded rubber*, *8434 Dairy machinery*, *7616 Other articles of aluminum*, *7314 Cloth of iron or steel wire*, *4008 Vulcanized rubber plates*, *3922 Baths, sinks etc.*, *8716 Trailers and semi-trailers*, *8433 Harvesting or agricultural machinery*).

The top 5 products in terms of the potential of increasing the sophisticatedness of Ukrainian export baskets are *5603 Nonwoven textiles*, *9021 Orthopedic appliances*, *8428 Other lifting machinery*, *3004 Medicaments, packaged* and *8434 Dairy machinery*. In this respect, many other target products included in the list have significantly high complexity gains.

The qualitative analysis through expert interviews highlighted the importance of Ukraine boosting its technological capabilities for storing agricultural products and improving transportation logistics. Some of the products included in the DIVE list above – for instance, *HS8418 Refrigerators, freezers* or preserved agricultural products, align with these considerations. Under these conditions, the issue of creating production facilities for processing is crucial since it will facilitate both the storage and transportation of agricultural products.

A few new options arise when considering the new specialization structure arising after the invasion and the lost ones, despite most of the products in the list being persistent. For example, assuming new specializations as persistent – and not volatile because measured on information gathered for a single year – several metal products show higher levels of desirability, such as *7308 structures and their parts, of iron and steel*, *7326 other articles of iron and steel*, *7408 copper wire*, *7321 stoves and similar non-electric appliances of iron or steel* or *7616 other articles of aluminium*. Other options are represented by *3814 organic composite solvents and thinner* and *8501 electric motors and generators*.

Table 4 | Short jumps with a high path dependence and many competitors[21]

Harmonized System 4-digit product code	Harmonized System 4-digit product description	Product sector	Complexity gain (USD, 2021)	Global trade % growth (2019-2021)	Import Penetration Index for Ukraine (World)	Import Penetration Index for Ukraine (EU markets)	Nr of countries for which product is in the Export Basket in 2019-21	of which LMI countries	Product proximity wrt Ukraine export products	Relative relatedness advantage (vis-à-vis LMI countries)	nr of times product entered Export Baskets (1995-2014)
7604	Aluminum bars	Metals	5228.47	36.670	1.171	1.787	39	5	0.617	0.193	9
401	Milk	Agriculture	9017.68	16.933	1.143	1.746	38	5	0.615	0.174	19
7212	Flat-rolled iron, width < 600mm, clad	Metals	11658.57	39.974	1.080	1.714	24	2	0.551	0.160	5
4005	Compounded rubber	Chemicals	15827.85	6.622	1.149	1.659	24	0	0.567	0.158	7
8434	Dairy machinery	Machinery	18054.54	-2.153	1.506	1.634	22	0	0.599	0.181	13
7616	Other articles of aluminum	Metals	8313.46	15.568	1.156	1.628	26	4	0.580	0.143	4
7314	Cloth of iron or steel wire	Metals	2739.85	44.002	1.090	1.599	31	1	0.610	0.155	6
4008	Vulcanized rubber plates	Chemicals	16074.46	10.911	1.187	1.550	22	2	0.597	0.159	6
3922	Baths, sinks etc.	Chemicals	2647.38	31.418	1.262	1.548	27	4	0.638	0.148	7
8716	Trailers and semi-trailers	Vehicles	10518.45	19.059	1.223	1.525	27	1	0.588	0.135	8
8433	Harvesting or agricultural machinery	Machinery	10119.39	29.415	1.249	1.523	25	1	0.663	0.204	8
9406	Prefabricated buildings	Textiles	8195.20	15.771	1.221	1.496	33	4	0.671	0.188	12
3209	Paints and varnishes, aqueous	Chemicals	3796.92	16.164	1.178	1.444	35	4	0.609	0.137	3
8476	Automatic goods-vending machines	Machinery	14359.12	-16.655	1.076	1.426	23	2	0.491	0.101	7
8503	Parts for use with electric generators	Electronics	6736.98	20.105	1.050	1.392	26	3	0.620	0.153	7
3003	Medicaments, not packaged	Chemicals	7818.05	-13.905	1.244	1.375	30	4	0.417	0.054	7
3214	Glaziers' putty	Chemicals	8252.94	17.066	1.192	1.330	31	4	0.634	0.171	7
3917	Plastic tubes and fittings	Chemicals	5237.17	22.565	1.115	1.319	41	5	0.559	0.112	22

[21] Appendix C shows the list of excluded products.

Harmonized System 4-digit product code	Harmonized System 4-digit product description	Product sector	Complexity gain (USD, 2021)	Global trade % growth (2019-2021)	Import Penetration Index for Ukraine (World)	Import Penetration Index for Ukraine (EU markets)	Nr of countries for which product is in the Export Basket in 2019-21	of which LMI countries	Product proximity wrt Ukraine export products	Relative relatedness advantage (vis-à-vis LMI countries)	nr of times product entered Export Baskets (1995-2014)
7610	Aluminum structures (bridges, towers etc)	Metals	3814.88	18.067	1.072	1.304	36	2	0.676	0.173	7
7019	Glass fibers	Stone	10982.02	17.172	1.093	1.301	30	3	0.467	0.100	12
4016	Other articles of vulcanized rubber	Chemicals	7461.85	11.382	1.115	1.299	27	3	0.560	0.134	5
4009	Vulcanized rubber tubes	Chemicals	5570.76	6.753	1.123	1.293	23	1	0.634	0.230	9
3921	Other plastic plates, sheets etc.	Chemicals	9218.51	21.616	1.060	1.290	35	0	0.599	0.136	12
403	Fermented milk products	Agriculture	3001.91	12.736	1.152	1.285	40	7	0.603	0.159	18
7008	Multiple-walled insulating glass	Stone	6609.31	12.281	1.045	1.276	23	1	0.638	0.205	6
8708	Parts of motor vehicles	Vehicles	8850.32	1.963	1.120	1.262	23	1	0.565	0.147	4
3503	Gelatin	Chemicals	6142.06	6.283	1.138	1.215	23	4	0.499	0.150	5
3402	Cleaning products	Chemicals	5348.50	19.048	1.084	1.204	41	7	0.664	0.203	17
9021	Orthopedic appliances	Machinery	21080.21	7.527	1.035	1.177	22	0	0.418	0.091	4
8537	Electrical boards	Electronics	7106.71	11.510	1.070	1.135	28	4	0.507	0.140	9
8538	Parts for electrical apparatus	Electronics	8007.82	14.668	0.952	1.135	25	4	0.493	0.097	11
8501	Electric motors and generators	Electronics	7430.78	13.683	1.029	1.124	24	4	0.566	0.179	8
8421	Centrifuges	Machinery	5999.86	20.473	1.087	1.119	22	1	0.495	0.103	3
3809	Finishing agents	Chemicals	14959.28	8.186	0.990	1.107	26	3	0.530	0.157	14
5603	Nonwoven textiles	Textiles	30419.14	24.953	1.003	1.106	24	1	0.522	0.153	7
4011	New pneumatic tires of rubber	Chemicals	8149.49	7.292	1.080	1.101	28	4	0.522	0.139	10
3208	Paints and varnishes, nonaqueous	Chemicals	6022.05	13.724	1.119	1.099	34	3	0.622	0.165	8
5703	Carpets, tufted	Textiles	5631.67	7.434	1.112	1.097	22	6	0.502	0.138	3
5911	Textile articles for technical use	Textiles	14450.04	10.388	1.023	1.087	23	0	0.623	0.215	7

Harmonized System 4-digit product code	Harmonized System 4-digit product description	Product sector	Complexity gain (USD, 2021)	Global trade % growth (2019-2021)	Import Penetration Index for Ukraine (World)	Import Penetration Index for Ukraine (EU markets)	Nr of countries for which product is in the Export Basket in 2019-21	of which LMI countries	Product proximity wrt Ukraine export products	Relative relatedness advantage (vis-à-vis LMI countries)	nr of times product entered Export Baskets (1995-2014)
3004	Medicaments, packaged	Chemicals	18225.68	14.334	1.095	1.085	32	2	0.483	0.093	7
6810	Articles of cement, of concrete or of artificial stone	Stone	5712.63	28.858	0.992	1.082	31	3	0.650	0.198	13
8418	Refrigerators, freezers	Machinery	7523.61	31.238	1.061	1.076	27	3	0.553	0.123	4
6807	Asphalt	Stone	7290.36	14.884	1.016	1.057	30	3	0.516	0.121	7
8428	Other lifting machinery	Machinery	20321.92	2.963	1.154	1.044	27	1	0.593	0.148	4
8530	Electric signal and traffic controls	Electronics	14260.33	6.527	1.093	1.031	23	0	0.612	0.164	12
3920	Other plates of plastics, noncellular and not reinforced	Chemicals	8471.16	22.884	0.993	1.030	37	4	0.527	0.102	9
3814	Organic composite solvents and thinners	Chemicals	5256.96	13.524	0.964	1.024	37	5	0.607	0.182	12
7005	Float glass	Stone	5537.47	21.468	0.905	0.990	31	5	0.495	0.139	15
8481	Appliances for thermostatically controlled valves	Machinery	16278.07	10.534	1.087	0.986	22	1	0.539	0.150	2
8504	Electrical transformers	Electronics	6591.67	27.846	0.927	0.962	23	5	0.459	0.106	3
3405	Polishes and creams	Chemicals	4305.92	14.223	0.903	0.934	23	3	0.474	0.105	3
3902	Polymers of propylene	Chemicals	8734.07	30.665	0.979	0.900	25	2	0.444	0.110	10
3006	Pharmaceutical goods	Chemicals	9602.14	11.277	1.021	0.897	25	0	0.459	0.099	6
8419	Equipment for temperature change of materials	Machinery	14754.29	9.961	1.191	0.896	24	0	0.559	0.129	4
7902	Zinc waste and scrap	Metals	3016.42	15.366	0.755	0.782	25	3	0.503	0.115	6
3901	Polymers of ethylene	Chemicals	8788.13	25.925	0.914	0.708	25	3	0.548	0.231	13
2905	Acyclic alcohols	Chemicals	4444.21	30.324	0.900	0.676	31	3	0.484	0.144	8
2711	Petroleum gases	Minerals	7671.39	41.918	0.820	0.654	34	11	0.440	0.149	17
5402	Synthetic filament yarn	Textiles	3217.21	14.622	0.947	0.620	22	4	0.458	0.096	8
8405	Water gas generators	Machinery	5903.19	-0.593	0.901	0.538	25	3	0.576	0.223	6

Data source: UNIDO elaboration, based on BACI and Gravity, Centre d'Études Prospectives et d'Informations Internationales and World Development Indicators, World Bank.

Note: Products are ranked by the relevance of export potential to the European Union market, as measured by the import penetration index. The list excludes agricultural products for synthesis reasons.

Set 2: Short jumps with a high path dependence and few competitors

These products have the same features as those described above but involve a limited number of competitors or countries with a comparative advantage in the product. A low number of competitors means a potentially high desirability due to lower competition. It also means that entry barriers might be relatively high (lower feasibility).

For this target list, the choice for the most strategic products is based on the same consideration reported above regarding the potential for enhancing the complexity of the country's export basket but also related to potential global demand for Ukraine, particularly from EU countries (import penetration indexes). It is interesting to notice that this second set includes many products in the machinery and chemical sectors. Several target products are related to the production of building materials.

According to preliminary estimates, 87 million m2 of housing have been destroyed in Ukraine. Its restoration will require a colossal amount of building materials. According to the results of the study presented in the White Paper Localization of Recovery in Ukraine about 15% of construction enterprises were damaged or destroyed. The production of flat glass and equipment for power distribution boards was practically destroyed. The largest capacity losses are noted in the production of dry gypsum mixtures (the destroyed Knauf and Siniat plants in Soledar and Bakhmut of the Donetsk region) and sheet metal (the destroyed MMK im. Ilyicha and Azovstal in Mariupol). Half of the PVC profile production facilities (Mayado and Viknalend plants in the Kyiv region) were also damaged. In other segments, capacity loss does not exceed 5-10%. According to experts, the sector generally maintains high production capacities for various construction materials. It can provide up to 90% of the materials needed for the country's reconstruction.

The production of ceramic goods (*HS6903*) was already relatively crucial in the pre-war period thanks to some leading companies' introduction of new technologies; this sector can also be reinforced within the current export basket with appropriate support.

Following the full-scale invasion of Ukraine and the shock on the country's industrial structure, two products in the list are provisionally among the new RCA in 2022. These are 3505 Dextrins and other modified starches – exports increased by 114% between 2021 and 2022, jumping from 9.6 USD million to 20.6 USD million (RCA 2.4) – and 8462 Machine tools for molding and forging metals for which exports have increased by 37% reaching 18.5 USD million in 2022 and an RCA equal to 1.04.

Regarding the diversification options built upon the RCA in 2022, these include many products different from those reported in Table 5 that are characterized by HS codes very close to those reported. This suggests that the new specializations – together with the lost ones – have influenced the diversification options distances with respect to the export basket, preserving the type of potential specialization targets, mainly concentrated in metals, machinery and chemicals sectors (e.g., *2925 Carboxyimide-function compounds* is replaced by *2910 Epoxides*, *8207 Interchangeable tools for hand tools* is replaced by *8203 Pliers, pincers and other metal hand-tools*, and *8480 Molding boxes for metal foundry* is replaced by *8463 Other machine tools for working metal*, without removal).

Table 5 | Short jumps with a high path dependence and few competitors[22]

Harmonized System 4-digit product code	Harmonized System 4-digit product description	Product sector	Complexity gain (USD, 2021)	Global trade % growth (2019-2021)	Import Penetration Index for Ukraine (World)	Import Penetration Index for Ukraine (EU markets)	Nr of countries for which product is in the Export Basket in 2019-21	of which LMI countries	Product proximity wrt Ukraine export products	Relative relatedness advantage (vis-à-vis LMI countries)	nr of times product entered Export Baskets (1995-2014)
7007	Safety glass	Stone	24536.28	10.941	1.059	1.488	21	1	0.657	0.237	3
7415	Screws and similar articles of copper	Metals	12449.45	26.009	1.079	1.483	14	1	0.632	0.322	1
9029	Meters	Machinery	7094.98	-2.077	1.117	1.426	14	1	0.486	0.200	8
3001	Heparin for therapeutic use	Chemicals	19858.60	36.442	1.049	1.409	12	0	0.457	0.164	2
8465	Machine tools for working wood	Machinery	24279.79	14.603	1.243	1.277	13	0	0.524	0.186	4
8603	Self-propelled railway coaches	Vehicles	14189.44	-3.856	1.157	1.271	8	0	0.515	0.255	7
4810	Paper and paperboard, coated with kaolin	Agriculture	24147.13	-0.445	1.130	1.265	13	0	0.478	0.195	4
8701	Tractors	Vehicles	10187.79	11.463	1.154	1.264	20	1	0.594	0.181	7
8507	Batteries	Electronics	9823.37	61.362	0.998	1.260	18	2	0.491	0.181	12
3002	Serums and vaccines	Chemicals	31914.25	70.483	1.072	1.235	18	0	0.554	0.213	4
8466	Parts and accessories for metal working machines	Machinery	15753.41	4.564	1.081	1.224	17	0	0.546	0.164	0
7223	Wire of stainless steel	Metals	11457.28	32.961	1.039	1.215	14	1	0.490	0.183	6
8208	Knives and blades for machines	Metals	25867.34	13.712	1.135	1.214	18	0	0.562	0.195	1
3821	Prepared culture media for micro-organisms	Chemicals	18721.67	60.976	1.092	1.200	13	0	0.591	0.230	4
8207	Interchangeable tools for hand tools	Metals	13274.90	6.022	1.093	1.198	16	0	0.660	0.286	4
8422	Dish washing machines	Machinery	24716.29	12.361	1.181	1.198	20	1	0.560	0.170	6
3507	Enzymes	Chemicals	25741.24	33.614	1.098	1.186	12	0	0.522	0.207	3
5910	Transmission belts or belting, of textile material	Textiles	14677.49	19.413	1.090	1.174	12	2	0.469	0.188	3
8209	Articles for utensils, of cermet	Metals	31959.85	9.422	1.056	1.164	11	1	0.522	0.249	1
3909	Amino-resins	Chemicals	13441.17	38.924	1.097	1.134	16	0	0.533	0.187	6
8707	Vehicle Bodies	Vehicles	14604.73	-11.830	1.531	1.130	19	0	0.599	0.217	8

[22] Appendix C shows the list of excluded products.

Harmonized System 4-digit product code	Harmonized System 4-digit product description	Product sector	Complexity gain (USD, 2021)	Global trade % growth (2019-2021)	Import Penetration Index for Ukraine (World)	Import Penetration Index for Ukraine (EU markets)	Nr of countries for which product is in the Export Basket in 2019-21	of which LMI countries	Product proximity wrt Ukraine export products	Relative relatedness advantage (vis-à-vis LMI countries)	nr of times product entered Export Baskets (1995-2014)
3505	Dextrins and other modified starches	Chemicals	7826.33	16.217	1.119	1.102	17	3	0.572	0.229	7
8467	Tools for hand working, pneumatic, hydraulic motors	Machinery	13953.18	29.529	1.087	1.100	14	0	0.511	0.208	6
7605	Aluminum wire	Metals	13817.85	26.526	1.040	1.097	19	2	0.439	0.134	14
8408	Compression-ignition internal combustion piston engines	Machinery	15015.35	-3.207	1.083	1.066	17	1	0.572	0.209	5
8443	Printers and copiers	Machinery	16500.59	0.744	0.931	1.063	12	1	0.514	0.219	9
7607	Aluminum foil < 0.2 mm	Metals	11215.19	24.607	0.987	1.050	21	1	0.513	0.188	5
4010	Conveyor belts of vulcanized rubber	Chemicals	8857.64	7.874	1.118	1.050	21	1	0.531	0.145	2
3504	Peptones	Chemicals	24986.77	38.288	1.049	1.048	14	0	0.543	0.220	8
3403	Lubricants	Chemicals	18357.39	10.121	1.116	1.046	14	0	0.519	0.169	2
9209	Parts of musical instruments	Machinery	51636.99	15.024	0.948	1.036	18	1	0.485	0.141	4
5902	Tire cord fabric	Textiles	41476.84	19.006	1.041	1.034	13	1	0.522	0.200	5
8506	Primary cells and primary batteries	Electronics	7021.87	9.877	0.939	1.026	16	0	0.500	0.192	6
3913	Natural polymers	Chemicals	14124.71	22.153	1.050	1.020	16	0	0.542	0.201	2
3506	Glues and adhesives	Chemicals	10145.39	18.619	1.010	1.017	18	1	0.581	0.223	3
8480	Molding boxes for metal foundry	Machinery	15714.93	-1.856	0.995	1.016	15	0	0.613	0.262	0
203	Pork	Agriculture	22147.76	11.465	0.890	1.014	15	0	0.572	0.220	2
8425	Pulleys and winches	Machinery	11636.40	9.858	1.138	1.012	15	0	0.494	0.170	2
8438	Machinery for the industrial preparation of food or drink	Machinery	14045.31	5.096	1.235	1.008	21	1	0.548	0.162	7
8515	Electric soldering machines	Electronics	13180.81	7.070	1.091	1.008	13	0	0.630	0.269	6
3911	Petroleum resins	Chemicals	14924.81	16.581	0.919	1.006	11	0	0.500	0.185	2
3906	Acrylic polymers	Chemicals	14931.65	21.734	1.063	0.992	16	0	0.540	0.182	3
8414	Pumps, compressors, fans, etc.	Machinery	7731.29	13.874	1.047	0.985	16	1	0.520	0.186	5
8451	Machinery for processing fabrics	Machinery	9484.43	16.864	1.029	0.985	12	0	0.511	0.190	7
8441	Other machinery for making paper	Machinery	15535.11	13.690	1.082	0.984	14	0	0.520	0.198	3

Harmonized System 4-digit product code	Harmonized System 4-digit product description	Product sector	Complexity gain (USD, 2021)	Global trade % growth (2019-2021)	Import Penetration Index for Ukraine (World)	Import Penetration Index for Ukraine (EU markets)	Nr of countries for which product is in the Export Basket in 2019-21	of which LMI countries	Product proximity wrt Ukraine export products	Relative relatedness advantage (vis-à-vis LMI countries)	nr of times product entered Export Baskets (1995-2014)
8459	Machine tools for drilling by removing metal	Machinery	10638.66	-9.559	1.174	0.983	14	1	0.520	0.180	10
8705	Special purpose motor vehicles	Vehicles	12156.25	-7.256	1.071	0.977	21	3	0.576	0.217	13
2918	Carboxylic acids with additional oxygen function	Chemicals	8494.85	27.119	1.044	0.972	17	2	0.500	0.187	7
7506	Nickel plates	Metals	23230.11	3.140	0.954	0.971	9	0	0.430	0.160	6
8540	Thermionic, cold cathode or photocathode tubes	Electronics	8370.98	17.529	1.022	0.960	14	0	0.468	0.166	11
5604	Rubber textiles	Textiles	5516.76	23.147	0.923	0.952	15	3	0.509	0.187	12
4004	Scrap of rubber	Chemicals	7713.99	9.690	0.982	0.938	20	1	0.596	0.231	6
8439	Machinery for making paper	Machinery	22992.10	3.596	1.253	0.933	13	1	0.564	0.245	3
2925	Carboxyimide-function compounds	Chemicals	15405.28	31.490	1.116	0.930	13	1	0.614	0.279	5
8462	Machine tools for molding and forging metals	Machinery	13301.57	-4.527	1.083	0.914	13	0	0.551	0.208	1
8709	Work trucks	Vehicles	10674.34	-9.038	0.940	0.901	20	0	0.533	0.137	6
8456	Machines for working materials by laser and similar means	Machinery	27645.61	12.592	0.978	0.892	14	0	0.578	0.241	5
6903	Other refractory ceramic goods	Stone	8542.55	13.304	1.125	0.885	15	2	0.500	0.164	1
8457	Machining centers for working metal	Machinery	28508.03	-4.887	1.089	0.877	11	0	0.451	0.188	2
3813	Preparations for fire extinguishers	Chemicals	18493.45	0.171	0.939	0.871	12	1	0.531	0.212	2
3812	Stabilizers for rubber or plastic	Chemicals	11518.60	24.137	1.011	0.862	15	1	0.479	0.172	3
3816	Refractory cements	Chemicals	11879.27	15.900	1.259	0.844	18	1	0.526	0.159	5
9014	Navigational instruments	Machinery	15023.68	-15.919	1.088	0.835	16	1	0.420	0.121	10
9022	X-ray machines	Machinery	17620.10	7.027	1.081	0.830	12	0	0.462	0.183	3
8461	Other machine tools for planing and cutting metals	Machinery	19094.48	-13.201	1.065	0.827	8	0	0.526	0.252	0
8475	Machines for assembling electric lamps	Machinery	26506.73	85.849	0.784	0.818	13	1	0.521	0.206	7

Harmonized System 4-digit product code	Harmonized System 4-digit product description	Product sector	Complexity gain (USD, 2021)	Global trade % growth (2019-2021)	Import Penetration Index for Ukraine (World)	Import Penetration Index for Ukraine (EU markets)	Nr of countries for which product is in the Export Basket in 2019-21	of which LMI countries	Product proximity wrt Ukraine export products	Relative relatedness advantage (vis-à-vis LMI countries)	nr of times product entered Export Baskets (1995-2014)
9006	Photographic cameras	Machinery	5013.07	12.468	0.863	0.809	15	4	0.493	0.182	7
8420	Calendering or other rolling machines, other than for metals or glass	Machinery	16002.33	15.434	1.134	0.803	11	0	0.553	0.236	2
1109	Wheat gluten	Agriculture	14422.70	27.810	1.090	0.792	13	1	0.487	0.210	5
9031	Measuring instruments	Machinery	11834.34	14.019	0.889	0.772	18	2	0.475	0.144	3
8463	Other machine tools for working metal, without removal	Machinery	15567.98	-9.959	1.092	0.760	15	1	0.551	0.230	2
7020	Other articles of glass	Stone	5865.22	3.902	0.807	0.753	14	2	0.444	0.156	8
8514	Industrial electric furnaces	Electronics	14658.48	3.106	1.005	0.744	14	1	0.542	0.180	4
8543	Electrical machines with individual functions n.e.c.	Electronics	14752.42	16.829	0.891	0.706	11	0	0.432	0.152	3
9001	Optical fibers	Machinery	13081.28	9.545	0.851	0.696	16	3	0.520	0.232	6
2909	Ethers	Chemicals	13753.27	12.275	0.768	0.693	16	2	0.448	0.175	6
8417	Industrial furnaces	Machinery	26902.25	-9.781	1.124	0.683	18	2	0.557	0.159	7
2920	Esters of other inorganic acids of nonmetals	Chemicals	19634.03	22.083	0.881	0.680	11	2	0.521	0.205	5
4002	Synthetic rubber	Chemicals	7182.43	24.142	0.862	0.675	19	3	0.504	0.179	6
2926	Nitrile-function compounds	Chemicals	10762.33	16.120	0.904	0.656	14	1	0.501	0.181	3
9508	Fairground amusements	Machinery	18969.01	-23.290	1.008	0.647	18	1	0.552	0.225	9
8534	Electronic printed circuits	Electronics	17794.78	26.427	0.571	0.579	10	3	0.432	0.137	6
9030	Instruments for measuring electricity	Machinery	11361.69	19.522	0.744	0.541	14	1	0.583	0.269	3
9302	Revolvers and pistols	Machinery	7776.95	84.100	0.812	0.233	14	1	0.463	0.162	3

Data source: UNIDO elaboration, based on BACI and Gravity, Centre d'Études Prospectives et d'Informations Internationales and World Development Indicators, World Bank.

Note: Products are ranked by the relevance of export potential to the European Union market, as measured by the import penetration index. The list excludes agricultural products for synthesis reasons.

Set 3: Long jumps with low path dependence, high frequency of new entries and few competitors

These products, reported in Table 6, are potential diversification targets for Ukraine, have low path dependence, and have a relatively high observed frequency of entry into the global economy. The combination of these two features suggests that the low initial relatedness with Ukraine's current export basket is not necessarily a severe constraint for developing a specialization in the product. We observe that many countries—even those with an unrelated initial specialization—have acquired a comparative advantage in the product. Moreover, these products might be particularly interesting as a policy target, provided they possess other characteristics (e.g., complexity, positive spillovers to the rest of the economy, strategic sectors), making them desirable for Ukraine.

Four products included in the list above are part of the chemical sectors (*HS3215*, *HS2932*, *HS3204*, *HS2829*). The complexity gain associated with these chemical products is relatively high, and the import penetration and vulnerability indexes are appreciable features of this set of products. It is interesting to notice that relatively new capabilities would be necessary. In the pre-war export basket, only a few regions (ex., Kyiv, Ivano-Frankivsk, Sumy and Mykolaiv) boosted a specialization in chemical products.

The set also includes four products belonging to the macro-sector of Electronics. Product *HS8525 Transmission apparatus* possesses interesting features and aligns with capabilities that have been boosted during the war effort. Also, *HS8505 Electromagnets* – for different considerations such as a high import penetration index toward the EU and a high relatedness advantage – is an interesting option for diversification. However, only three countries have acquired a competitive advantage in this product during the last two decades (a signal of relatively high entry barriers). Among the machinery products, *9018 Medical instruments* and *8402 Steam boilers* are worth mentioning. By considering the RCA computed on export data from 2022, no remarkable differences are registered for this set of diversification options.

Table 6 | Long jumps with low path dependence, high frequency of entry and few competitors[23]

Harmonized System 4-digit product code	Harmonized System 4-digit product description	Product sector	Complexity gain (USD, 2021)	Global trade % growth (2019-2021)	Import Penetration Index for Ukraine (World)	Import Penetration Index for Ukraine (EU markets)	Nr of countries for which product is in the Export Basket in 2019-21	of which LMI countries	Product proximity wrt Ukraine export products	Relative relatedness advantage (vis-à-vis LMI countries)	nr of times product entered Export Baskets (1995-2014)	Product index of vulnerability
3215	Ink	Chemicals	18891	2.8	1.16	1.56	21	4	0.37	0.05	11	0.67
8520	Magnetic tape recorders	Electronics	9111	28.8	1.10	1.27	11	2	0.38	0.10	5	0.38
8505	Electromagnets	Electronics	8913	27.9	0.94	1.17	9	2	0.38	0.13	3	0.22
9018	Medical instruments	Machinery	6772	12.6	1.01	1.00	19	2	0.36	0.07	5	0.49
2932	Heterocyclic compounds with oxygen hetero-atom(s) only	Chemicals	17646	24.4	0.97	0.98	15	2	0.37	0.09	10	0.59
7903	Zinc powders	Metals	8928	7.4	0.91	0.78	18	3	0.38	0.11	6	0.59
7503	Nickel waste and scrap	Metals	14150	-14.8	1.01	0.78	20	4	0.36	0.06	9	0.64
8521	Video recording apparatus	Electronics	5242	24.4	0.91	0.77	13	2	0.41	0.12	10	0.54
8525	Transmission apparatus for radio, telephone and TV	Electronics	13089	17.1	0.90	0.77	14	2	0.37	0.11	15	0.68
3204	Synthetic organic coloring matter	Chemicals	8564	8.8	0.90	0.76	18	4	0.41	0.09	3	0.41
5309	Woven fabrics of flax	Textiles	14368	-8.4	0.79	0.73	14	2	0.40	0.08	4	0.35
2829	Sodium chlorate	Chemicals	8044	-5.4	1.06	0.64	11	2	0.32	0.10	6	0.48
8402	Steam boilers	Machinery	6575	-29.5	0.88	0.47	18	4	0.41	0.10	5	0.48
5504	Artificial staple fibers, not processed for spinning	Textiles	12474	15.7	1.20	0.41	9	2	0.34	0.06	5	0.43

Data source: UNIDO elaboration, based on BACI and Gravity, Centre d'Études Prospectives et d'Informations Internationales and World Development Indicators, World Bank.

Note: Products are ranked by the relevance of export potential to the European Union market, as measured by the import penetration index. The list excludes agricultural products for synthesis reasons.

[23] Appendix C shows the list of excluded products.

Set 4: Long jumps with a high path dependence, low relatedness and relatedness advantage

These are products in Ukraine's potential diversification space that have a high degree of path-dependence, i.e., products for which an economy's initial capabilities matter substantially for the acquisition of a comparative advantage in those products, and which are characterized by a low degree of relatedness with the country's export basket. In other words, these products are relatively far from Ukrainian's current export basket and for which the feasibility of acquiring a specialization is hence relatively low. Considering Ukraine's current specialization basket, these targets are more ambitious. To diversify away from the current comparative advantage, these products are particularly interesting but are typically excluded from the standard policy approach (for example, the Product Space approach). Although these targets are more ambitious, we include products in this set for which the Ukrainian economy still has some strategic advantage compared to other upper middle-income countries and might be strategic in the light of the post-war industrial needs or the light of a trajectory of deeper integration in the EU economy and Global Value Chains. We employ the existence of a positive relatedness gain as an additional criterion, which suggests that Ukraine is more closely related to the product compared to other countries at a similar level of development.

The reconstruction effort is likely to absorb essential resources for an extended period. Industrial capabilities might be coordinated to provide the required inputs for the post-war reconstruction effort and, at the same time, generate new specialization oriented to both the domestic and foreign markets. Building materials will be in huge demand – these are interesting targets for future industrial and diversification strategies; several products are included in the target list reported in Table 7 (*6914 Other ceramic articles*; *7006 Worked glass*), but also other Tables above identify these products that are likely to be in high demand in the short-to-medium term as targets. Experts' opinions converge in deeming these sectors as strategic. For some products – such as glass - industrial capabilities have been affected or are primarily located in conflict areas; for other products, capabilities are mostly present, but a coordination effort promoted by public authorities will be needed. One example, often mentioned by experts in qualitative interviews, is that of de-mining machines. Some existing production plants might be re-converted to producing these specialized vehicles. Estimates suggest that approximately 30% of the territory of Ukraine has been contaminated by explosive ordnance, amounting to 174,000 square kilometers, with different degrees of presence of mines and explosive devices. The need for de-mining machines will be considerable. It will require innovative approaches and technological capabilities that the war effort has already generated (e.g., reconnaissance software and drones, armed vehicle production, and optical equipment).

Also, in this case, considering the RCA computed on export data from 2022, the diversification options list does not differ from the one obtained by considering the DIVE tool's export basket for 2019-2021.

Moreover, none of the diversification strategies reported in as long jumps are listed among the new export specializations that arose after the beginning of the conflict. This suggests that the most immediate adjustments that the country's economic structure shows in the short term as a response to the external shock induced by the war are mainly driven by path dependency.

Table 7 | Long jumps with a high path dependence, low relatedness and relatedness advantage[24]

Harmonized System 4-digit product code	Harmonized System 4-digit product description	Product sector	Complexity gain (USD, 2021)	Global trade % growth (2019-2021)	Import Penetration Index for Ukraine (World)	Import Penetration Index for Ukraine (EU markets)	Nr of countries for which product is in the Export Basket in 2019-21	of which LMI countries	Product proximity wrt Ukraine export products	Relative relatedness advantage (vis-à-vis LMI countries)	nr of times product entered Export Baskets (1995-2014)	Product index of vulnerability
8519	Sound reproducing apparatus	Electronics	9266.38	16.596	1.177	1.556	12	1	0.395	0.128	12	0.582
2933	Heterocyclic compounds with nitrogen hetero-atom(s) only	Chemicals	38083.31	2.439	1.112	1.507	11	1	0.211	0.020	6	0.449
9003	Frames for spectacles, goggles	Machinery	12593.03	7.524	0.918	1.122	10	1	0.368	0.105	4	0.331
2817	Zinc oxide or peroxide	Chemicals	4747.55	24.406	0.899	1.083	21	6	0.414	0.087	10	0.659
9405	Lamps	Textiles	5944.42	20.902	1.074	1.062	12	1	0.407	0.143	2	0.299
8536	Electrical apparatus for < 1k volts	Electronics	3370.97	16.250	0.933	1.043	29	4	0.409	0.078	5	0.567
8527	Reception apparatus for radio broadcasting	Electronics	3608.68	-16.285	0.979	1.012	12	1	0.385	0.079	5	0.395
2934	Nucleic acids and their salts	Chemicals	34076.05	38.475	1.034	1.009	11	1	0.347	0.083	6	0.402
9025	Thermometers, hydrometers etc.	Machinery	14092.31	36.259	1.015	1.008	19	2	0.379	0.043	8	0.568
3302	Mixtures of odoriferous subtances	Chemicals	2456.44	10.608	1.064	1.001	18	5	0.327	0.057	8	0.589
2936	Vitamins	Chemicals	25208.72	22.452	0.974	0.972	14	2	0.412	0.096	7	0.485
6914	Other ceramic articles	Stone	4957.19	26.380	0.962	0.939	14	4	0.392	0.115	4	0.417
8518	Microphones	Electronics	13419.32	23.556	0.932	0.931	14	1	0.377	0.102	3	0.309
9019	Therapy applicances	Machinery	16657.04	58.474	1.013	0.901	15	1	0.338	0.082	5	0.446
2911	Acetals and hemiacetals	Chemicals	16562.58	18.043	0.968	0.859	7	1	0.349	0.096	4	0.291
8415	Air conditioners	Machinery	5625.85	14.786	0.963	0.855	17	1	0.410	0.128	3	0.387
2938	Glycosides	Chemicals	9327.17	29.717	1.159	0.823	11	3	0.319	0.079	5	0.396
9011	Optical microscopes	Machinery	17107.52	8.015	1.040	0.812	10	1	0.412	0.192	4	0.284

[24] Appendix C shows the list of excluded products.

Harmonized System 4-digit product code	Harmonized System 4-digit product description	Product sector	Complexity gain (USD, 2021)	Global trade % growth (2019-2021)	Import Penetration Index for Ukraine (World)	Import Penetration Index for Ukraine (EU markets)	Nr of countries for which product is in the Export Basket in 2019-21	of which LMI countries	Product proximity wrt Ukraine export products	Relative relatedness advantage (vis-à-vis LMI countries)	nr of times product entered Export Baskets (1995-2014)	Product index of vulnerability
8472	Other office machines	Machinery	4708.60	-5.830	1.134	0.794	12	2	0.415	0.135	10	0.581
9016	Balances of a sensitivity < 50 milligram	Machinery	33127.76	-13.637	1.022	0.783	7	1	0.337	0.101	2	0.322
8529	Parts of radios, telephones, and T.V.s	Electronics	4041.76	12.048	0.840	0.768	10	3	0.293	0.040	7	0.423
2710	Petroleum oils, refined	Minerals	3219.09	5.220	0.699	0.651	60	10	0.396	0.061	20	0.840
2713	Petroleum coke	Minerals	3265.14	11.269	0.906	0.636	35	3	0.355	0.037	14	0.801
2810	Oxides of boron; boric acids	Chemicals	12986.12	22.085	0.777	0.598	9	1	0.282	0.080	2	0.188
9009	Electrostatic photo-copyers	Machinery	3831.03	-5.918	0.771	0.510	15	2	0.406	0.108	3	0.337
4702	Chemical woodpulp, dissolving grade	Agriculture	8808.94	18.116	0.841	0.474	16	1	0.335	0.037	8	0.566
7006	Worked glass	Stone	13249.72	40.197	0.649	0.381	7	1	0.371	0.103	6	0.387
2802	Sulfur, sublimed or precipitated	Chemicals	4539.19	21.534	0.837	0.300	10	1	0.324	0.104	4	0.313
4007	Vulcanized rubber thread and cord	Chemicals	2251.99	43.006	0.866	0.239	4	1	0.156	-0.017	3	0.300
8542	Electronic integrated circuits	Electronics	13318.91	35.641	0.444	0.228	13	2	0.394	0.090	3	0.266

Data source: UNIDO elaboration, based on BACI and Gravity, Centre d'Études Prospectives et d'Informations Internationales and World Development Indicators, World Bank.

Note: Products are ranked by the relevance of export potential to the European Union market, as measured by the import penetration index. The list excludes agricultural products for synthesis reasons.

The regional dimension of diversification strategies

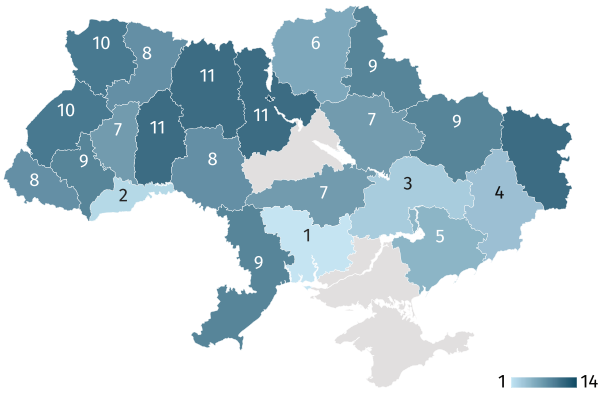
By focusing on the regional export patterns – reported in Table 8 and Figure 4 – reflecting the existing capabilities, it is possible to assess whether some of the target sectors identified in the country-level analysis are already present in the Oblasts' export baskets. Table 8 reports that the most targeted sector is *84 Nuclear reactors, boilers, machinery* comprising eight HS4 products in the short jumps/many competitors diversification strategy, 22 products in the short jumps/few competitors strategy, four products in the long jumps/low path-dependency option set and three products among those identified as long jumps/high path-dependency. Other sectors mainly targeted in our analysis of potential selected products are *39 Plastics, polymeric materials* and *40 rubber products* (DIVE list 1), *85 Electrical machines* (DIVE lists 1, 2 and 4), *87 means of land transport, other than railway* (DIVE list 2), tanning extracts (DIVE list 3), *29 organic chemical compounds* and *90 optical and photographic instruments and apparatus* (DIVE list 4).

The sector with the highest number of location quotients higher than unity (regional export share higher than national export share) is 04 milk and dairy products, poultry eggs; natural honey: half of the provinces are relatively specialized in exporting products in such sector. Rather ubiquitous sectors are also 21 miscellaneous food products and 94 furniture, with LQ>1 in ten Regions. Less ubiquitous production at the regional level are 15 Fats and oils of animal or vegetable origin and 81 other non-precious metals, present in only one province (Transcarpathian and Zaporizhzhya regions, respectively). By combining information on ubiquity and the number of HS4 products identified for each sector, the most promising directions are those relative to diversification in nuclear reactors, boilers, machinery (38 products in the four lists and sectors present in 8 different provinces) and electrical machines (19 products in the four lists and sector present in 8 provinces).

The province with the highest sectoral production concentration is the Kyiv region, in which 19 sectors record an LQ higher than unity, followed by the Kyiv City region (16), Volyn region (15) and Khmelnytsky, Luhansk and Lviv regions (14 specializations). By considering the information on the number of products in the HS2 sector present in the different regions (reported in the maps in Figure 4), the most endowed regions in terms of capabilities related to targeted products at the country level are Kyiv city, Kyiv region, Zhytomyr, Ivano-Frankivsk and Volvyn for the diversification list 1, Kharviv, Zaporiska, Volynska and Ivano-Frankivsk for the list 2, the western regions of Volyn, Zakarpattia, Ivano-Frankivsk and Zhytomyr for the lists 3 and 4. It is worth noticing how the eastern regions – those mainly involved in the conflict in Eastern Ukraine - are well endowed with capabilities related to path-dependent diversification strategies. It is also evident from the figures that the Luhansk region has significant production in sectors targeted in all four diversification strategies.

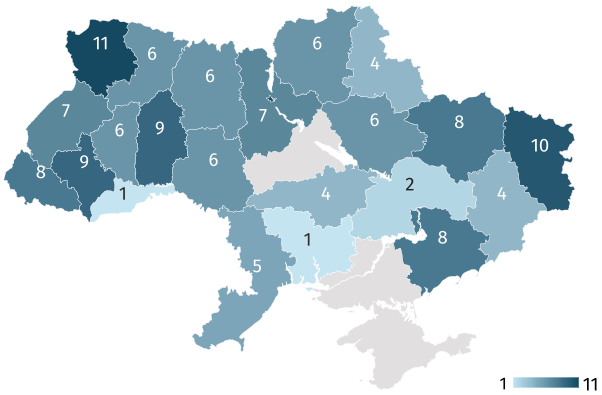
Figure 4 | Geographical distribution of Ukrainian location quotients in sectors with diversification options, the average of 2017-2021

Short jumps, few competitors



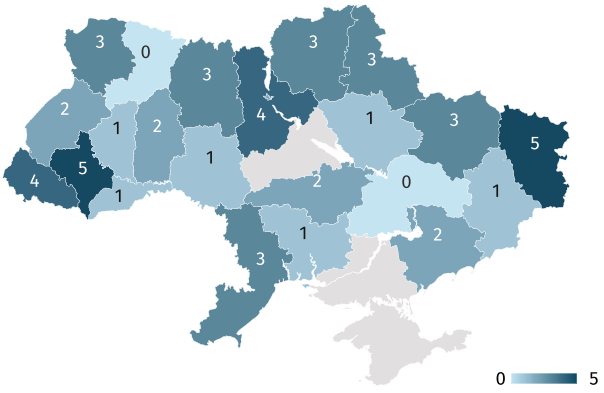
The number of Ukraine's diversification strategies in HS2 sectors for which regions have a Location Quotient (LQ) > 1

Short jumps, many competitors



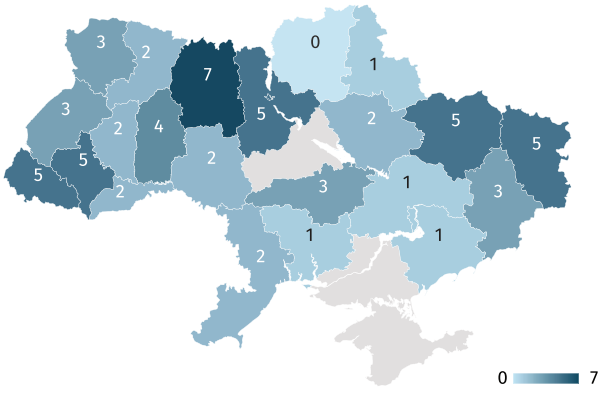
The number of Ukraine's diversification strategies in HS2 sectors for which regions have a Location Quotient (LQ) > 1

Long jumps, low entry barriers



The number of Ukraine's diversification strategies in HS2 sectors for which regions have a Location Quotient (LQ) > 1

Long jumps, capability advantage



The number of Ukraine's diversification strategies in HS2 sectors for which regions have a Location Quotient (LQ) > 1

Data source: UNIDO elaboration based on State Statistics Service of Ukraine and Centre d'Études Prospectives et d'Informations Internationales.

Note: The boundaries, names and designations on this map do not imply UNIDO's official endorsement or acceptance.

Table 8 | Diversification strategies and regional capabilities

Products HS2-digits classification	short jumps w/ many competitors	short jumps w/ few competitors	long jumps w/ low path dependency	long jumps w/ high path dependency	Regions with a location quotient above unity in the sector exports
84 nuclear reactors, boilers, machinery	9	22	4	3	Donetsk region;Ivano-Frankivsk region;Kharkiv region; Kirovograd region;Sumy region;Volyn region;Zaporizhzhya region;Zhytomyr region.
85 electrical machines	6	7	0	6	Chernivtsi region;Ivano-Frankivsk region;Khmelnytsky region;Lviv region;Ternopil region;Transcarpathian region; Volyn region;Zhytomyr region.
90 optical and photographic instruments and apparatus	1	7	0	5	Kharkiv region;Khmelnytsky region;Kyiv city;Kyiv region; Luhansk region;Odesa region;Transcarpathian region.
39 plastics, polymeric materials	6	4	0	0	Ivano-Frankivsk region;Kharkiv region;Khmelnytsky region;Kyiv region;Luhansk region;Sumy region;Ternopil region;Volyn region.
29 organic chemical compounds	1	5	1	5	Ivano-Frankivsk region;Kirovograd region;Luhansk region; Odesa region;Poltava region;Transcarpathian region; Vinnytsia region.
87 means of land transport, other than railway	2	4	1	0	Dnipropetrovska oblast;Kharkiv region;Poltava region; Rivne region;Sumy region;Transcarpathian region;Volyn region;Zaporizhzhya region.
35 protein substances	1	4	0	0	Ivano-Frankivsk region;Khmelnytsky region;Luhansk region;Mykolaiv region;Ternopil region;Vinnytsia region; Volyn region;Zaporizhzhya region.
40 rubber, rubber products	5	3	0	1	Kirovograd region;Kyiv region;Luhansk region;Zhytomyr region.
38 miscellaneous chemical products	2	4	0	0	Kyiv city;Kyiv region;Luhansk region;Vinnytsia region; Zaporizhzhya region.
70 glass and glassware	3	2	0	1	Kharkiv region;Kyiv region;Luhansk region;Rivne region; Zhytomyr region.
82 tools, knife products	0	3	1	0	Khmelnytsky region;Kyiv region;Lviv region;Poltava region; Rivne region;Sumy region.
04 milk and dairy products, poultry eggs; natural honey	2	0	0	0	Ivano-Frankivsk region;Khmelnytsky region;Kirovograd region;Kyiv region;Poltava region;Rivne region;Sumy region;Ternopil region;Vinnytsia region;Volyn region; Zhytomyr region.
59 textile materials	1	2	0	0	Kyiv city;Lviv region;Poltava region;Rivne region;Ternopil region;Transcarpathian region;Volyn region.
30 pharmaceutical products	3	2	0	0	Kharkiv region;Kyiv city;Kyiv region;Luhansk region.
94 furniture	1	0	0	1	Chernivtsi region;Kharkiv region;Khmelnytsky region;Kyiv region;Lviv region;Rivne region;Ternopil region; Transcarpathian region;Volyn region;Zhytomyr region.
27 mineral fuels; petroleum and its distillation products	1	0	0	2	Dnipropetrovska oblast;Donetsk region;Ivano-Frankivsk region;Kyiv city;Lviv region;Poltava region.
34 soaps, surfactants	2	1	0	0	Ivano-Frankivsk region;Khmelnytsky region;Kirovograd region;Kyiv city;Lviv region;Vinnytsia region.
76 aluminium and products of aluminium	3	2	1	0	Khmelnytsky region;Kyiv region;Odesa region.
48 paper and cardboard	0	1	1	0	Ivano-Frankivsk region;Kyiv region;Luhansk region;Lviv region;Volyn region;Zhytomyr region.
68 Articles of stone, plaster, cement	2	0	0	0	Ivano-Frankivsk region;Kyiv region;Luhansk region;Lviv region;Poltava region;Zhytomyr region.
21 miscellaneous food products	1	0	0	0	Khmelnytsky region;Kirovograd region;Kyiv city;Kyiv region;Lviv region;Rivne region;Sumy region;Vinnytsia region;Volyn region;Zhytomyr region.
32 tanning extracts	3	0	2	0	Kyiv city;Sumy region.
69 ceramic products	0	1	0	1	Donetsk region;Kharkiv region;Khmelnytsky region;Kyiv city;Zhytomyr region.
73 products of ferrous metals	1	0	0	0	Dnipropetrovska oblast;Donetsk region;Kharkiv region; Lviv region;Odesa region;Rivne region;Sumy region; Zhytomyr region.
01 live animals	1	0	0	0	Kirovograd region;Kyiv city;Kyiv region;Odesa region;Rivne region;Sumy region;Ternopil region.
28 inorganic chemicals	0	0	1	3	Ivano-Frankivsk region;Mykolaiv region.
47 mass of wood	1	0	0	1	Kyiv city;Luhansk region;Vinnytsia region;Zhytomyr region.

Products HS2-digits classification	short jumps w/ many competitors	short jumps w/ few competitors	long jumps w/ low path dependency	long jumps w/ high path dependency	Regions with a location quotient above unity in the sector exports
54 synthetic or artificial threads	1	0	0	0	Khmelnytsky region;Luhansk region;Lviv region;Odesa region;Transcarpathian region;Volyn region;Zhytomyr region.
56 cotton wool	1	1	0	0	Kharkiv region;Poltava region.
74 copper and copper products	0	1	1	0	Donetsk region;Volyn region;Zaporizhzhya region.
02 meat and edible offal	0	1	0	0	Kyiv region;Rivne region;Ternopil region;Vinnytsia region; Volyn region.
11 products of the flour and cereal industry	0	1	0	0	Khmelnytsky region;Kyiv city;Kyiv region;Vinnytsia region.
49 printed matter	1	0	0	0	Kyiv city;Kyiv region;Lviv region;Sumy region.
53 other textile fibres	0	0	1	0	Kyiv city;Luhansk region;Sumy region.
72 ferrous metals	1	1	0	0	Donetsk region;Zaporizhzhya region.
86 railway locomotives	0	1	0	0	Dnipropetrovska oblast;Odesa region;Poltava region; Volyn region.
16 meat and fish products	1	0	0	0	Kyiv region;Odesa region;Vinnytsia region.
33 essential oils	0	0	0	1	Kyiv city;Kyiv region;Transcarpathian region.
55 synthetic or artificial staple fibres	0	0	1	0	Kharkiv region;Kyiv city.
92 musical instruments	0	1	0	0	Ivano-Frankivsk region;Lviv region;Transcarpathian region.
57 carpets	1	0	0	0	Khmelnytsky region;Odesa region.
75 Nickel and products from it	0	1	0	0	Luhansk region;Zaporizhzhya region.
79 zinc and products of zinc	1	0	0	0	Odesa region;Transcarpathian region.
15 Fats and oils of animal or vegetable origin	0	1	0	0	Transcarpathian region.
81 other non-precious metals	0	1	0	0	Zaporizhzhya region.
95 toys	0	0	0	0	Ivano-Frankivsk region;Lviv region;Odesa region;Rivne region;Ternopil region;Transcarpathian region;Volyn region.
Total of HS4 sectors in the DIVE Sets	65	84	15	30	

Data source: UNIDO elaboration, based on State Statistics Service of Ukraine and Centre d'Études Prospectives et d'Informations Internationales.

Note: The table reports the number of HS4 products listed in DIVE target lists (Tables 4-7) in each HS2 sector. The list of Ukrainian regions with a location quotient (regional export share over country export share) above unity is reported in the last column for each sector. Their diffusion among regional capabilities ranks the HS2 sectors.

Concluding remarks

There is a clear consensus on the need for a credible and comprehensive strategy for Ukraine's industrial recovery. The need for export and production base diversification was already evident before the conflict, and the full-scale invasion of Ukraine has not only amplified this need. Still, it has created new urgencies related to reconstructing the pre-existing production capabilities and the need to address newly emerging territorial inequalities.

The design of diversification and industrial policies is a complex task that relies on comprehensive methods and information. The aim of this report - based on the application of the UNIDO DIVE tool and expert opinions - is to highlight information that could support the prioritization of target products/sectors in diversification and reconstruction policy. The tool provides a helpful diagnosis of the main characteristics of Ukrainian's export basket, highlighting notable features such as its structural vulnerability, i.e., the potential of other countries to specialize in products that belong to the current export basket and to analyze the ability of the country to acquire or recombine production capabilities, a key ingredient of structural change.

The Ukrainian economy scored significantly worse in terms of diversification than other countries at a similar level of development. Notwithstanding a growing process of integration in the global economy (the country entered into WTO in 2008 and signed a trade agreement with the UE in 2016), the country's export basket is highly concentrated in two macro-sectors, agriculture and metals, and mainly within these sectors in low complexity products. The analysis of recent (pre-conflict) new entries or export surges does not positively assess the country's ability to defy its static comparative advantage.

Our analysis assesses the 'direction' diversification strategies could take. The application of the DIVE tool led to the definition of a list of potential products that might represent new sectors/areas of diversification. This should be considered a first step in defining potential targets with the aim of a more in-depth analysis of specific value chains and the identification of critical enabling factors (e.g., evolving technologies, likely demand, key industrial and institutional players) as well as market failures and bottlenecks that might prevent the development of the target sectors. Targets have a strategic value related to domestic firms' actual and/or potential linkages. The analysis should also highlight those sectors connected by backward and forward linkages that are already competitive or might become competitive soon with adequate policy stimuli (Farooki and Kaplinsky, 2014).

The analysis also provided additional insights into factors that must be addressed to reconstruct the Ukrainian economy successfully. The first element is related to the governance of the diversification and reconstruction effort. The government, the primary owner of this process, must formulate the country's industrial policy vision and priorities. Many expert opinions pointed to the need to create a central government body responsible for industrial policy in the country. In the current framework, there is a lack of a coherent legal and administrative framework for industrial policy. The Ministry of Economy is responsible for developing some industries, while the Ministry of Industry and Trade is responsible for developing others. More coordinators across Ministries and different levels of government (central-regional-municipal) would be essential.

A second clear element from the analysis carried out in this report is the need to intensify the adaptation of Ukrainian production standards to European ones. The changing geopolitical landscape implies that socioeconomic and political ties will be boosted in a westward direction. To allow a business to re-adjust to this new scenario, the State should create a program of information and consulting support for entrepreneurs adapting to the European requirements.

Many products/sectors reported in the DIVE target lists (Tables 52-55) are coherent with the reconstruction and diversification strategies discussed between the Government of Ukraine and

the EU. In particular, we refer to the 'Ukrainian Facility Programme,' a special instrument managed by the European Commission to provide short- and medium-term financing for Ukraine's recovery and reconstruction needs over 2024-2027.[25] Facility plans are being developed for the following strategic macro-sectors: agriculture, energy, transport and logistics, IT, critical infrastructure, and machine building. The areas of support in the Ukrainian Facility Fund program are divided into three components: 1 – direct financial support to the "Plan of Ukraine," which is to be prepared by the Ukrainian government in autumn 2023. 2 – attraction of additional public and private investment to support the "Plan of Ukraine." 3 – Provision of technical assistance to strengthen institutional capacity and harmonize EU Acquis. The funds provided under the Ukrainian Facility Programme will also support the implementation of critical reforms for Ukraine's rapid accession to the EU and transition to a green, digital and inclusive economy; these reforms will be instrumental for a successful diversification strategy, particularly in sectors where trade barriers are relatively high due to regulations and rigid standards applied by EU countries.

Public procurement is needed as an effective industrial policy tool in the post-war reconstruction effort. Considering the exceptional circumstances and the need to rebuild and expand industrial capacities and provide job opportunities in areas most affected by the war, local content provisions in public procurements shall be wisely employed to balance the need for effective recovery with that of industrial policy. On the other hand, effective public procurements must tackle corruption issues, removing as much discretionary power of public officials as possible and introducing more effective preventive measures.[26]

Given the extensive damage to the existing infrastructures, industrial parks might also be an essential tool in the policy mix that can speed up the process of industrial recovery. The Government of Ukraine is promoting several amendments to the legislation on industrial parks to stimulate their development. Damages to critical infrastructures (transport, energy, water supply and treatment) make the case for well-managed and endowed industrial parks compelling. Targeting public support schemes and incentives for developing strategic sectors might also be more effective. The role of municipalities and the regional State administrations in industrial recovery will also be necessary, but to date, these administrations have limited roles and resources.

The war has generated a critical shortage of specialists across most sectors. Some human capital has relocated abroad or to other regions, and some have been called up for service in the Armed Forces of Ukraine. Scientific and technological capabilities will also change the pre-war development trajectory based on a few unsophisticated sectors. The high quality of human capital – the development of the IT sector is a good indicator of this – and the existing universities and research centers will have a central position in a

[25] For details see European Commission (2023) Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on establishing the Ukraine Facility. Available at: https://ec.europa.eu/commission/presscorner/detail/da/qanda_23_3353

[26] On July 14, 2022, the Law of Ukraine No. 1977-IX came into force, which amends the Law of Ukraine *On Public Procurement* in the part of requirements for the degree of localization of production. According to the document, from mid-2022, at least 10% is required in state tenders for the purchase of urban transport, municipal equipment, railway transport, aerospace products and energy engineering products. The threshold will increase by 5% annually until the national production quotient reaches 40%. The law allows the Cabinet of Ministers to expand the list of goods subject to the localization requirement, increase by 10% or decrease by 5% the localization requirement for a specific category of goods per year. It also allows to reduce the level of the local component to zero in a particular procurement in case of urgent needs.

coherent strategy for industrial upgrades.[27] The loss and limited development of human resources could be a barrier to diversification and industrial recovery that should be adequately addressed in the future.

Another fundamental economic infrastructure that will represent a pre-condition for a successful diversification strategy is the banking and financial sector. Interviews with private companies' executives in war-affected regions suggest that small and medium-sized enterprises were strongly affected, mainly through the deterioration of financial conditions. Even before the conflict, the allocation of credit – primarily controlled by state-controlled financial institutions - was considered one of the main obstacles to diversification and, more in general, to the development of the private sectors (mainly SMEs). An effective credit provision to private companies will be the engine of reconstruction.

Finally, it is essential to underline that the reconstruction effort will likely be quicker and more effective with the active involvement of the Ukrainian diaspora. It would be fundamental to transform what is now a drain of human resources (hopefully temporary) into a lever to promote the development of new production capacities.

[27] Investment in science and higher education will be particularly important in the border regions affected by the conflict. The area of Kharkiv, one of the industrial engines of the country before the war, is an emblematic example. As of July 1st, 2021, 1.426 million people lived in Kharkiv and about 300 thousand students studied in the more than 60 higher educational institutions in the area. Although reliable statistics are not yet available, it is estimated that hundreds of thousands of people – mostly young – have left.

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References

- Agosin, M. R. (2007). "Export diversification and growth in emerging economies." CEPAL Review, (93), 7-23
- Balassa, B. (1965), Trade Liberalisation and "Revealed" Comparative Advantage. The Manchester School, 33: 99–123.
- Cadot, O., Carrère, C., & Strauss-Kahn, V. (2011). "Export diversification: What's behind the hump?". Review of Economics and Statistics, 93(2), 590-605.
- Coniglio, N.D., Vurchio, D., Cantore, N. and Clara, M. (2021). On the evolution of comparative advantage: Path-dependent versus path-defying changes. Journal of International Economics, Volume 133.
- Coniglio, N.D., Vurchio, D., Cantore, N. and Clara, M. (2022), New export specializations, structural transformation and path-dependence: new evidence and methodologies, ISID Working Papers X, Vienna.
- European Commission (2023), Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on establishing the Ukraine Facility, COM(2023) 338 final 2023/0200 (COD).
- Farooki Masuma and Raphael Kaplinsky (2014). Promoting diversification in resource-rich economies. Mineral Economics, Vol. 27:103–113.
- Hausmann R. and Hidalgo, C. (2011). The network structure of economic output. Journal of economic growth, vol. 16(4), December.
- Hausmann R. Hwang, J. and Rodrik, D. (2007). What you export matters. Journal of Economic Growth, vol. 12(1), pages 1-25, March.
- Hausmann R., and D. Rodrik. (2003). Economic Development as Self-discovery. Journal of Development Economics, vol. 72:603–633.
- Hesse, Heiko (2008). Export Diversification and Economic Growth. Commission on Growth and Development Working Paper; No. 21. World Bank, Washington, DC. http://hdl.handle.net/10986/28040
- Hidalgo C. and Hausmann R. (2009). The Building Blocks of Economic Complexity. Papers 0909.3890, arXiv.org
- Hidalgo, C., Klinger, B., Barabasi, A. and Hausmann, R. (2007). The Product Space Conditions the Development of Nations. Science Magazine 317(5837): 482-487.
- Inter-American Development Bank. (2014). Rethinking productive development: Sound policies and institutions for economic transformation. New York, NY: Palgrave Macmillan.
- Khaustova et al. (2024). Analysis of industrial production and exports of goods from Ukraine and its regions, 2013-2022, https://downloads.unido.org/ot/33/85/33859241/WP_2_2024.pdf?_ga=2.133894983.879927738.1711466840-1753516124.1711466840
- OECD/WTO (2019). Aid for Trade at a Glance 2019: Economic Diversification and Empowerment. OECD Publishing, Paris, https://doi.org/10.1787/18ea27d8-en.
- Orihuela, José Carlos and Victor Gamarra Echenique (2019). Volatile and spatially varied: The geographically differentiated economic outcomes of resource-based development in Peru, 2001–2015. The Extractive Industries and Society, vol. 6, pp. 1143-1155.

- UNIDO (2012). Promoting industrial diversification in resource intensive economies—the experiences of Sub-Saharan Africa and Central Asia Regions, http://www.unido.org/fileadmin/user_media/Publications/Research_and_statistics/Branch_publications/Research_and_Policy/Files/Reports/Other_Reports/Promoting%20Industrial%20Diversification%20Report.pdf
- UNIDO (2016). UNIDO Industrial Development Report, "The role of technology and innovation in inclusive and sustainable industrial development," Vienna. https://www.unido.org/resources-publications-flagship-publications-industrial-development-report-series/industrial-development-report-2016
- UNIDO (2023), "Provision of services for survey of supply chains in post–conflict conditions in Ukraine," UNIDO report.
- UNIDO (2024), "Ukraine: Industrial Diagnostic Study", UNIDO.

Appendix A: Methodological details

a. Identification of export baskets

Using trade data HS 4-digit Rev. 1992, we adopt the Balassa index of revealed comparative advantage to quantify the degree of export specialization for each product *i*, each country *k* and each year *t*. The index of export specialization is computed as follows:

$$RCA_{ikt} = \frac{\frac{x_{ikt}}{\sum_i x_{ikt}}}{\frac{\sum_k x_{ikt}}{\sum_i \sum_k x_{ikt}}}$$

Where x_{ikt} is the export value of product *i* in country *k* at time *t*. The Balassa index is computed for all years for which data are available. A product is only included in a country's export basket if its RCA was above unity for at least two years in the interval $[t,t+2]$.

b. Computation of relatedness between products

Following Hidalgo et al. (2007), we compute the network of relatedness as the minimum of the pairwise conditional probability of being co-exported with an RCA above unity over a three-year period $[t,t+2]$. The relatedness between product *i* and product *j* at time *t* is thus computed as follows:

$$\varphi_{ijt} = min\{P(EB_{it}/EB_{jt}, P(EB_{jt}/EB_{it})\}$$

where EB_{it} denotes the presence of product *i* in the export basket at time *t*. The degree of similarity in the capability required to produce different goods changes over time, and thus for computing distances in terms of relatedness, we adopt year-specific networks.

c. New export specializations

A product is a new export specialization at time *t* if:

1. it is exported with an RCA higher than unity at time *t*;
2. it has been exported with an RCA lower than 0.5 for at least two in the previous 5 years;
3. it has never been exported with an RCA higher than unity in the previous 5 years;
4. alternatively,
    1. it has been exported with an RCA higher than unity for at least 2 years in the following 5 years and has been exported with an RCA lower than 0.5 for no more than once in the following 5 years;
    2. it has been exported with an RCA higher than unity in the following 3 years;
5. the average export value in the following 5 years is higher than the average export values in the previous 5 years;
6. the export value at time *t* is higher than USD 1 million.

d. The option set (OS)

To be included in a country's OS and in line with ex-ante criteria for the identification of new entries, a product is part of the diversification (or option) set if it:

1. is exported with an RCA lower than unity at time *t*;
2. is exported with an RCA lower than 0.5 for at least two years in the previous 5 years;
3. is never exported with an RCA higher than unity in the previous 5 years.

We retrieved information of countries' option sets for the period 2000–2019.

e. Distance between new entries/products in the OS and pre-existing export basket

The degree of relatedness between products outside the export basket and those already being exported with an RCA is given by the degree of proximity between such new entries/products in the OS and the closest products among those in the export basket.

$$dist_{i,EB_{kt}} = max\{\varphi_{ij}\} \; with \; j \in EB_{kt}$$

where product i is the new entry (or alternatively, the product in the diversification set) and EB_{kt} is the country's export basket at time t. In our approach, we focus on this definition, avoiding measures of average distance from the overall export basket, e.g. network density metrics. A measure of network density is reliable in a context of an ex-ante forecast of potential new entries and, as reported in many works that adopted the PS framework, is correlated with the probability of entering a country's export basket. Our analysis relies on the distance of actual new entries and potential ones to export baskets, and we virtually attach the new entries that are close to the most related product. Averaging over the entire set of proximities would underestimate the degree of relatedness of products with high similarities in terms of local capabilities with only a few existing specializations.

To compute the relatedness of new export specializations and products in the diversification space at time t, we adopt relatedness matrices referred to as time $t - 5$ so that the proximity is computed a priori, thus avoiding endogeneity.

f. Product index of path departure

To detect the extent to which a product usually follows 'the path', we have developed three alternative metrics that capture distinct aspects of diversification. The three metrics focus on the country-product dimension to capture the country-specific heterogeneity of product path dependence and subsequently, aggregate the information on path departure at the product level.

The first step is to identify the average proximity of the products in the OS for each country and each initial year. This represents the threshold for distinguishing between path-dependent and path-defying new entries.

- Relative distance from threshold: the first metrics compute the extent to which a single new entry defies the path and is given by the ratio between the difference in relatedness between the threshold and the new entry and the threshold value, as follows:

$$ipd_{ikt} = \frac{\mu_{kt} - dist_{i,EB_{kt}}}{\mu_{kt}}$$

where μ_{kt} is the country-time-specific threshold and $dist_{i,EB_{kt}}$ is the distance between new entry i and the pre-existing export basket of country k at time t - 5. The index has a positive value when the new entry has a lower proximity to the export basket than the OS, on average. The metrics obtained thereby are subsequently aggregated at the product level for the entire period of analysis, as follows:

$$IPD_i = \frac{\sum_t \sum_k ipd_{ikt}}{|NE_i|}$$

where $|NE_i|$ is the number of total new entries of product i in the period considered.

- Share of path-defying new entries: by adopting the threshold value introduced above, we assign a dichotomic value to each new entry: if the relatedness is higher than the average proximity of the OS, it represents a path-dependent new entry; by contrast, if the relatedness of the new entry is lower than the average proximity of the OS, it is labelled as a path-defying new entry.

$$d\_ipd_{ikt} = \begin{cases} 1 \; if \; \mu_{kt} > dist_{i,EB_{kt}} \\ 0 \; otherwise \end{cases}$$

The product-level metrics, similarly to the previous one, is computed as follows:

$$d\_IPD_i = \frac{\sum_t \sum_k d\_ipd_{ikt}}{|NE_i|}$$

- The third metrics take the entire distribution of the OS's relatedness distribution into consideration. Each new entry's inverse measure of distance from the export basket ($dist_{i,EB_{kt}}$) is associated with a percentile in the distribution of the OS ranging from 0 to 100. Higher values denote path-dependent new entries, thus we transform this value into a measure of path departure as follows:

$$percentile_{ikt} = 1 - rank_{OS,ikt}/100$$

The path departure product-country-time-specific metrics are subsequently transformed into a product-specific measure of path departure as follows:

$$av\_perc\_dep_{it} = \frac{\sum_t \sum_k percentile_{ikt}}{|NE_i|}$$

g. Product and country index of vulnerability

As reported in the main text, a vulnerable product is one with a high level of path departure (low path dependence suggests that the set of available local capabilities is not difficult to acquire), high ubiquity (due to the fact that capabilities are present in several countries, so international competition is high), and high frequency of entry (high level of contestability in the middle-long run).

All three dimensions are computed using an index with values ranging from 0 to 1. For frequency and ubiquity, the product value is obtained as the relative position (percentile) of its frequency/ubiquity with respect to other products' frequency/ubiquity. A value of 1 is assigned to products that entered export baskets the most. A value of 0.5 is assigned to products in the middle of the distribution. The value of the degree of product-level path defiance is computed by:

1. comparing new entry relatedness with the pre-existing export basket with the OS's relatedness distribution and obtaining a value for each new entry in each country;
2. averaging the product-country relative position in the OS distribution across countries. Products with a value of 1 have the lowest level of relatedness of all products in the OS.

The three dimensions are joint in a unique index computed as follows:

$$IPV_i = \frac{\sqrt{freq_i^2 + pathdepa_i^2 + ubiq_i^2}}{\sqrt{3}}$$

where the index of product vulnerability of product *i* is equal to the square root of the sum of the square of the three components divided by the square root of 3 (the denominator serves to obtain an index ranging in the [0,1] interval). Assuming the product index of frequency, the product index of path departure and the product index of ubiquity as three dimensions represented as a 3x1 vector, the numerator corresponds to its norm.

Moving to the country dimension, we can easily compute the index of structural vulnerability for the export basket. This is obtained as the weighted average of the indices of product vulnerability, where the weights are given by the export shares of product *i* of country *k*.

$$ISV_k = \sum_i sh_{ik} IPV_i$$

h. Country index of path departure

All product indices of path departure presented have been used to obtain a metric that is valid for the entire set of products exported by each country. Similarly to the measure adopted, with ipd_i denoting the product index of path departure, the country measure is obtained as follows:

$$IPD_k = \sum_i sh_{ik} ipd_i$$

where IPD_k indicates, alternatively, the country's relative distance from path dependence, the share of path-dependent new entries or the average percentile position of the country's export basket.

i. Country index of structural dynamism

By considering one measure that has already been introduced, i.e. the country index of path departure (as measured by the percentile method) and the number of new entries of each country in the period analysed, we obtain a country index of structural dynamism (*ISD_k*), which gives a measure of how dynamic an economy's export basket is over a given period (in our case, 1995–2019).

We have already introduced the country index of path departure. The number of a country's new entries is normalized in the interval [0.1] by assigning a value to each country that corresponds to its relative position in the distribution of countries' new entries number. In other words, the country with the highest number of new entries over the period analysed, i.e. the country that witnessed the biggest changes in its set of specializations, has a value equal to 1. If a country has no entries, it has a value very close to 0.

Similarly to the country index of structural vulnerability, we have added the two dimensions as follows:

$$ISD_i = \frac{\sqrt{NE\_rank_i^2 + pathdepa_i^2}}{\sqrt{2}}$$

where NE_rank_i is the relative position of country i in the distribution of world economies according to the number of new entries in the period 1995–2019. The denominator serves as a correction to obtain an index bounded in the interval [0,1].

Appendix B: Definitions and key concepts

Revealed Comparative Advantage (RCA) is an index that can be used to compute the relative advantage—or disadvantage—of an economy in producing a certain product or class of products using international trade data. In its best-known formulation, the Balassa index of RCA of an economy *c* in the production of a good *c* is given by the ratio between the relative value of good *i* exports over country *c* total exports (country export share of product *i*) and the relative value of good *i* exports over global total exports (world export share of product *i*). Values lower than 1 reflect a country's disadvantage in the production of a product while values higher than unity reflect a country's relative advantage in the production of a product. Its success is due to its ability to proxy the underlying structure of an economy since it allows identification of which (set of) class of products an economy is specialized in, or 'the export basket' (the bundle of products exported with an RCA higher than 1).

Path dependence/path defiance. A path-dependent new entry occurs when a newly introduced specialization is related to the existing export basket. By contrast, with path departure (or path defiance), we indicate the case in which a new economic specialization is characterized by the presence of production capabilities non-strictly related to those already developed in a country.

Export basket: the set of products[28] countries have a specialization in. The export basket is identified measuring RCAs. In this study, using export data[29], we analyse how export baskets change over time or in other words, we identify 'new entries' in the export basket in recent decades for all countries in the world. One of the core novelties of the DIVE tool is the assessment of the degree of "path dependence" of these new product specializations.

The Product Space (PS). The PS is a network representation of all goods traded in the world in which every good is linked to others according to its "relatedness". Hidalgo et al. initially presented the PS in a seminal contribution published in 2007, entitled "The Product Space Conditions the Development of Nations". The authors highlight the role of path dependence in the process of a country's specialization over time. As economies' export mix changes, there is a strong tendency to move towards related goods rather than to goods that are less related.

Relatedness. The theoretical concept of relatedness refers to the degree to which the set of production capabilities required for specialization in the production of two products (say product A and product B) overlap. The empirical measure of relatedness is the (minimum of) pairwise probability that products A and B are co-exported with a revealed comparative advantage higher than 1 (RCA>1). See Hidalgo et al. (2007) and Appendix A for details on how relatedness is computed.

Relatedness advantage. We define this measure as the difference between the relatedness of product i to the export country of the country under analysis (in our case Peru) and its relatedness with other countries at a similar level of development. A higher advantage signals that the country is in a better position to diversify towards the product compared to potential competitors; this concept is relevant for products characterized by a high level of path dependence (low level of path defiance).

Product sophistication or complexity (PRODY). Products are complex or sophisticated when they require a complex set of productive capabilities that are generally abundant and available in high productivity economic contexts (for instance those that characterize rich and developed

[28] We identify products according to the Harmonized System (HS) nomenclature, Rev. 1992.

[29] We adopt the BACI dataset provided by CEPII.

economies). In this report, we measure product complexity by employing the PRODY index developed by Hausmann et al. (2007).

Sophistication or complexity gain. We report a measure of the gain in complexity associated with a new entry (actual or potential), which is given by the difference between the product's PRODY and the country's EXPY. The higher the gain, the higher the potential of a product to increase a country's level of production complexity.

Country sophistication or complexity (EXPY). Using the values of the PRODY of products belonging to countries' export baskets, we measure the aggregated level of complexity or sophistication. Empirical results show that the measures of complexity are positively correlated with level of income, and that deviations from this relationship are predictive of future growth.

Diversification space or option set. The diversification space, alternatively referred to as option set (OS), is the country-time-specific bundle of products representing potential specializations that have not yet been developed. For each country and for each year of analysis, the OS represents the bundle of potential new entries.

Appendix C: The list of excluded products of tables 4-7

Short jumps with a high path dependence and many competitors (excluded products)

Harmonized System 4-digit product code	Harmonized System 4-digit product description	Product sector	Complexity gain (USD, 2021)	Global trade % growth (2019-2021)	Import penetration index for Ukraine (World)	Import penetration index for Ukraine (EU markets)	Nr of countries for which product is in the Export Basket in 2019-21	of which LMI countries	Product proximity wrt Ukraine export products	Relative relatedness advantage (vis-à-vis LMI countries)	nr of times product i entered ExpBaskets between 1995 and 2014
1601	Sausages	Agriculture	1807.26	18.54	1.22	1.76	37	2	0.68	0.18	4
105	Fowl	Agriculture	6812.51	3.88	1.00	1.73	34	6	0.60	0.19	12
4901	Books, brochures etc.	Agriculture	5052.36	-2.77	1.08	1.40	26	3	0.49	0.10	9
2309	Animal feed	Agriculture	2744.51	31.13	1.12	1.37	42	5	0.50	0.05	12
710	Frozen vegetables	Agriculture	547.58	4.03	1.07	1.26	33	6	0.54	0.13	8
4817	Letterstock	Agriculture	9479.47	9.80	1.01	1.21	26	2	0.47	0.08	8
1602	Other prepared or preserved meat	Agriculture	5984.59	3.45	1.03	1.18	33	3	0.57	0.13	7
506	Bones, simply prepared	Agriculture	368.87	18.41	0.89	1.06	22	3	0.54	0.15	9
201	Beef	Agriculture	2690.75	19.82	0.91	1.06	27	2	0.46	0.08	11
4707	Paper waste	Agriculture	8487.75	38.00	0.83	0.88	43	4	0.65	0.18	11
2106	Food preparations n.e.c.	Agriculture	10250.58	20.92	0.92	0.86	49	6	0.58	0.10	12
206	Edible offal	Agriculture	11280.97	16.42	0.77	0.42	24	2	0.44	0.08	9

Short jumps with a high path dependence and many competitors (excluded products)

Harmonized System 4-digit product code	Harmonized System 4-digit product description	Product sector	Complexity gain (USD, 2021)	Global trade % growth (2019-2021)	Import penetration index for Ukraine (World)	Import penetration index for Ukraine (EU markets)	Nr of countries for which product is in the Export Basket in 2019-21	of which LMI countries	Product proximity wrt Ukraine export products	Relative relatedness advantage (vis-à-vis LMI countries)	nr of times product i entered ExpBaskets between 1995 and 2014
1506	Other animal fats and oils	Agriculture	10103.50	71.08	1.27	2.79	14	0	0.51	0.18	11
103	Swine	Agriculture	27047.24	-4.39	1.25	2.47	19	1	0.50	0.15	9
208	Other meat	Agriculture	19276.12	-3.15	1.11	1.95	21	2	0.47	0.10	5
1522	Degras and wax residues	Agriculture	399.16	23.42	1.00	1.88	17	2	0.54	0.20	8
210	Preserved meat	Agriculture	4694.39	5.33	1.20	1.80	16	1	0.46	0.15	9
1518	Animal or vegetable fats and oils, processed	Agriculture	7640.12	82.71	0.94	1.78	20	2	0.51	0.19	21
4910	Calendars	Agriculture	7394.93	2.74	1.12	1.42	15	0	0.50	0.18	2
4801	Newsprint	Agriculture	25301.69	-21.81	1.06	1.35	13	0	0.48	0.18	5
4804	Uncoated kraft paper and paperboard	Agriculture	12492.14	12.18	0.89	1.04	21	1	0.42	0.05	5
4202	Trunks or cases	Agriculture	8207.66	0.45	0.91	0.88	17	7	0.43	0.10	4

Short jumps with a high path dependence and many competitors (excluded products)

Harmonized System 4-digit product code	Harmonized System 4-digit product description	Product sector	Complexity gain (USD, 2021)	Global trade % growth (2019-2021)	Import penetration index for Ukraine (World)	Import penetration index for Ukraine (EU markets)	Nr of countries for which product is in the Export Basket in 2019-21	of which LMI countries	Product proximity wrt Ukraine export products	Relative relatedness advantage (vis-à-vis LMI countries)	nr of times product i entered ExpBaskets between 1995 and 2014	Product index of vulnerability
4108	Chamois leather	Agriculture	319.46	-21.75	1.08	1.65	11	3	0.33	0.06	4	0.41
705	Lettuce	Agriculture	6.27	12.60	1.09	1.65	13	5	0.35	0.08	7	0.48
4802	Paper used for graphic purposes	Agriculture	8673.26	-10.02	0.99	0.95	20	2	0.38	0.09	6	0.57
204	Lamb	Agriculture	11296.08	31.14	0.93	0.77	18	3	0.28	0.02	6	0.55

Short jumps with a high path dependence and many competitors (excluded products)

Harmonized System 4-digit product code	Harmonized System 4-digit product description	Product sector	Complexity gain (USD, 2021)	Global trade % growth (2019-2021)	Import penetration index for Ukraine (World)	Import penetration index for Ukraine (EU markets)	Nr of countries for which product is in the Export Basket in 2019-21	of which LMI countries	Product proximity wrt Ukraine export products	Relative relatedness advantage (vis-à-vis LMI countries)	nr of times product i entered ExpBaskets between 1995 and 2014	Product index of vulnerability
302	Fish, excluding fillets	Agriculture	1220.72	11.95	1.18	1.89	47	11	0.384	-0.003	9	0.73
4501	Natural cork, raw	Agriculture	1918.31	-11.80	0.85	1.74	6	3	0.250	0.058	2	0.10
305	Preserved fish	Agriculture	10493.76	1.23	1.06	1.53	43	10	0.409	-0.003	8	0.71
901	Coffee	Agriculture	-10269.91	20.25	1.14	1.44	41	12	0.367	-0.007	3	0.60
701	Potatoes	Agriculture	154.61	-10.34	1.06	1.23	36	9	0.403	0.033	6	0.64
304	Fish fillets	Agriculture	7246.99	6.10	1.04	1.21	49	13	0.356	-0.034	11	0.76
812	Fruits and nuts, provisionally preserved	Agriculture	-9147.46	7.27	0.95	1.17	12	3	0.373	0.111	3	0.33
704	Cabbages, cauliflowers, broccoli	Agriculture	-5975.33	12.87	0.98	1.16	24	9	0.396	0.035	9	0.66
4106	Tanned skins of other animals	Agriculture	-9308.48	-44.20	0.70	0.84	19	9	0.301	0.002	6	0.51
4101	Raw hides of bovines or equines	Agriculture	-7654.20	-21.27	0.81	0.81	20	3	0.339	0.068	10	0.62
2201	Waters	Agriculture	-5106.56	2.27	0.93	0.80	26	2	0.409	0.083	10	0.68
906	Cinnamon	Agriculture	-9617.70	21.64	0.82	0.47	8	4	0.343	0.105	1	0.23
1511	Palm oil	Agriculture	-10224.37	69.54	0.92	0.38	27	11	0.257	-0.083	9	0.69
4102	Raw skins of sheep or lambs	Agriculture	-2145.49	-1.20	1.04	0.29	24	2	0.286	0.003	6	0.58

Data source: UNIDO elaboration, based on BACI and Gravity, Centre d'Études Prospectives et d'Informations Internationales and World Development Indicators, World Bank.

Note: Products are ranked by the relevance of export potential to the European Union market, as measured by the import penetration index.

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