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Introduction

The Russian full-scale invasion of Ukraine is entering its third year, and the debate around aiding the war-torn country is increasingly shifting towards empowering Ukraine's domestic defence industry, to make it more autonomous against a larger and more resourceful opponent. At the same time, in 2023 the former Ukrainian Minister of Strategic Industries Oleksandr Kamyshin suggested that the EU could also benefit from this process by learning from the evolution of Ukraine's defence industry (EDA, 2023). This paper will thus give a brief overview of the condition of the country's industry before and after the war with Russia and summarise the main lessons that the EU can incorporate from the Ukrainian experience.

The Evolution of Ukraine's Defence Industry: From Independence to the Annexation of Crimea

A. Ukrainian Defence Industry

After the fall of the Soviet Union, Ukraine inherited a large defence industrial base. This included 750 factories and 140 scientific and technical institutions employing over 1 million people capable of producing tanks, armoured vehicles, aircraft, radars, electronics, missiles and ships (McLees & Rumer, 2014; Congressional Research Service, 2022). At the time, however, Ukraine was coexisting peacefully with its neighbours and its struggling economy did not allow it to maintain a defence complex of that dimension, paving the way for massive downsizing (Honrada, 2023). By the time Russia annexed Crimea in 2014, Ukraine could count on 300 defence enterprises and a base of 250.000 people (McLees & Rumer, 2014). Its defence industry focused primarily on exports, with Russia being one of its main customers (McLees & Rumer, 2014). After Russia's aggression in 2014, arms exports to the country predictably stopped, but this damaged Ukraine's arms producers (Lafitte, 2022) and left the country unprepared to sustain a high-intensity war with Russia in 2022. Since the beginning of the full-scale invasion, Ukraine has been heavily dependent on arms supply from the West. However, as the commitment of Western partners grows more and more uncertain, Ukraine is working to develop its military industrial complex to become less reliant on its partners and properly equip its armed forces (Barigazzi, 2024). Ukraine's strategy to enhance its defence-industrial base is twofold: on the one hand, the nation seeks to strengthen and expand the activities of its arms producers, and on the other, it aims to conclude strategic partnership and joint ventures with EU and NATO countries (Miller & Russell, 2023; Reuters, 2024). This will allow Ukraine to increase the production of both homegrown and Western systems on its own territory.

In addition to the state-owned manufacturer Ukroboronprom, which was transformed into a joint stock company and renamed Ukraine Defence Industry (UDI), Ukraine can now count on 400 private defence companies, half of which produce drones (Andersson & Ditrych, 2024). Research and development funding remarkably increased, from a prewar figure of \$162 million to \$1.3 billion in 2023, whereas military procurement touched its 20-year-highest level of \$10 billion in the same year (Jakes, 2024). According to the Ukrainian minister Rustem Umerov, Ukraine already spent \$7 billion in domestic military procurement up to August 2024 (The New Voice of Ukraine, 2024). Ukraine's reforms and investment on its military industrial base has visible effects on the battlefield. Some examples can be found in artillery, armoured vehicles, drones and missile capabilities:

Artillery: In 2023, Ukraine produced 42 times more mortar rounds and 2.5 times more Soviet-era artillery shells than the pre-invasion period (Stepanenko et al., 2024). Ukraine has also restarted the production of its Vilkha Multiple Rocket System and increased the manufacturing of its homegrown self-propelled 2S22 Bohdana howitzer (Stepanenko et al., 2024). The Bodhana howitzer is the only Ukrainian-produced system capable of firing NATO standard 155mm artillery shells. While only one existed in 2018, today Ukraine produces 8 Bodhana howitzer systems per month (Jakes, 2024). Indeed, Ukraine has discovered that the 155 mm artillery shell, which is one of the most needed projectiles on the battlefield, is one of the hardest munitions to produce due to the scarcity of raw material and licensing rights from Western partners (Jakes, 2024). Nevertheless, Ukraine started the production of this shell type in small quantities around September 2023 (Stepanenko et al., 2024).

Armoured Vehicles: The production of armoured vehicles has also experienced an increase. Between 2022 and 2023 Ukraine's Armoured Personnel Carrier (APC) production increased 3 times and in 2023 alone it increased another 5 times (Stepanenko et al., 2024). Nevertheless, Ukraine does not have the capability of domestically manufacturing new tanks, so for this it still remains completely reliant on Western supplies (Axe, 2024).

Drones: Drone development and production is perhaps the area in which Ukraine is most proficient. Drone production has increased more than 100 times since the start of the full-scale invasion and Ukrainian officials claim that the industry will supply the armed forces with about one million FPV drones this year (Stepanenko et al., 2024). Innovation is key in the Ukrainian drone industry and new systems rapidly appear on the battlefield, as in the case of the new Dragon Drone equipped with thermite munitions (Kastehelmi, 2024) or the new Palianytsia missile-drone hybrid for long-range strikes (UNITED24 Media, 2024). Given the restriction placed on the use of Western missiles inside Russia, drones represent the only relevant domestic long-range strike capability currently in service in the Ukrainian armed forces (Defence Industry Europe, 2024). These drones are usually employed to hit Russian oil refineries and other critical infrastructures (Wax, 2024), and some of them have a range of over 1000km (Defence Industry Europe, 2024).).

Sources inside the Ukrainian government report that the country allocated \$2 billion for drone manufacturing this year and will be able to produce 1000 such drones by the end of 2024 (Dickinson, 2024).

Missile capabilities: While drone technology is undoubtedly useful, Ukraine requires additional capabilities to strike deep in Russian territory and disrupt its infrastructure and logistics. For this reason, Ukraine is racing to build its own cruise and ballistic missiles. For example, Ukraine adapted its famous Neptune anti-ship missile into a land-based cruise missile (Defence Industry Europe, 2024) and reportedly used it against land targets on at least one occasion (Goksedef & Chervonenko, 2023). Recently, Ukrainian President Zelenskyy announced that Ukraine has had successes in developing its own ballistic missiles, although no more details were given (Defence Industry Europe, 2024).

While these examples show that Ukraine has made remarkable progress in enhancing its own defence industrial complex, several Ukrainian officials highlight that funding remains a major issue (Jakes, 2024). This lack of economic resources prevents Ukraine from scaling up the production of domestic weaponry, forcing Ukraine to remain dependent on Western aid (Jakes, 2024).

B. Ukraine and NATO/EU Industrial Defence Cooperation

The second strategy employed by Ukraine to bolster arms production is concluding partnerships and joint ventures with European arms manufacturers to produce systems domestically. This is a mutually beneficial process, as it allows Western defence enterprise to grow while increasing the capacity to manufacture and repair Western weapons systems in Ukraine.

One of the most notable partnerships in this sense is that between the Ukraine Defence Industry and the German defence company Rheinmetall, whose plant in Ukraine is already repairing armoured vehicles and is set to produce Fuchs APCs, Lynx Infantry Fighting Vehicles (IFVs) and 155 mm artillery shells (Andersson & Ditych, 2024). The German company Flensburger Fahrzeugbau and the English giant BAE Systems are also on the ground supporting Ukraine with the repair of its equipment (Andersson & Ditych, 2024), while the Franco-German KNDS intends to open a subsidiary to produce spare parts and ammunition (Andersson & Ditych, 2024). Reportedly, Ukraine and Sweden also signed a declaration of intent to produce the Swedish CV90 IFVs (Zhelikhovskiy, 2024).

EU and NATO countries are supporting Ukraine's drone industry as well. The German company Quantum Systems opened a production site in Ukraine this year (Andersson & Ditych, 2024). The Turkish company Baykar, which manufactures the popular Bayraktar TB2 drone, has also agreed to invest \$100 million to build a service centre, a head of office and a drone production plant in the country (Zhelikhovskiy, 2024).

Finally, the US military-industrial giant Northrop Grumman intends to cooperate with Ukraine on the production of medium-calibre munitions on Ukrainian soil, possibly expanding the activity to 155 mm artillery shells and tank munitions (Insinna, 2024). While these partnerships are surely beneficial to the defence industries of the EU, NATO and Ukraine, and represent a viable strategy to reduce Ukraine's dependence on the Western aid while increasing its chances of success against Russia (Stepanenko et al., 2024), there is a lack of cooperation in critical areas, most notably air-defence and missiles capabilities (Khvostova & Kryvosheiev, 2023).

Ukraine's Defence Industry and Lessons for the European Union

The Ukrainian experience demonstrates how crucial it is to have a defence industrial base that can sustain a country's armed forces in the event of a war. It also offers important lessons about how EU member states should reshape their defence industry to better prepare for future challenges. One of these is autonomy, especially when it comes to the use of advanced weapons systems. The Russian invasion of Ukraine has demonstrated that missile strikes in the enemy's rear are essential for successful combat operations, which means that reliance on foreign systems subject to restrictions is a major disadvantage. Indeed, Ukraine is currently not allowed to use Western missiles to strike targets deep inside Russia's territory and discussions about lifting the restriction are only taking place in these days (Liptak, 2024). Some European countries are already equipped with indigenous missile capabilities, such as the French/English SCALP-EG/Storm Shadows or the Swedish-German Taurus. Nevertheless, the quantity and quality of these systems can hardly compete with those of the EU's adversaries, Russia in particular (CSIS, 2021). For this reason, the EU should invest in more autonomy and longer-range capabilities involving several member states. The European Long Strike Approach (ELSA) led by France is an example of a step in this direction (Defence Industry Europe, 2024).

According to EU High Representative Josep Borrell, a second lesson that the EU should learn pertains to innovation (Borrell, 2023). This is particularly true when it comes to drone technology, one of the most significant in today's battlefield. The EU should heavily incentivise the creation of EU-based drone enterprises which would implement the lessons learned by Ukraine on the frontlines and produce technologically advanced but cost-effective drone systems, something Western arsenals currently lack (Sommerville & Forrest, 2024). While the European Drone Strategy 2.0 is an initiative that deserves attention, it is still heavily oriented towards civilian and dual-use drone technologies (European Commission, 2022). Given the current European defence requirements, the EU should devote more resources to the development of military-focused drone systems.

Finally, High Representative Borrell mentioned that the EU defence-industrial base lacks the mass and capabilities to scale up production and equip European armies for long and attritional wars (Borrell, 2023). A cost-effective way to address this issue would be to replicate what European arms manufacturers are building in Ukraine and incentivise mergers, joint ventures and partnerships of European defence companies. In that way it would be possible to create giants of industry, not only capable of adequately supplying the armed forces of the EU's Member States in the event of war, but also able to compete with larger international defence companies on the world market in times of peace.

Conclusion

The Ukrainian military-industrial complex has shown it is capable of achieving remarkable results through innovation and adaptation in its ongoing conflict with Russia. In the first section it has been explained how, despite years of downsizing and underinvestment in the post-independence period, as well as Russian occupation and attacks on its infrastructure, Ukraine was able to grow and increase production of essential systems such as artillery and armour while establishing an advanced drone industry (Stepanenko et al., 2024). Nevertheless, Ukraine's limited financial resources prevent the country from mass-producing the weapons it needs and becoming less reliant on Western aid (Jakes, 2024), which will likely remain indispensable in some critical areas such as tanks and missiles (Axe, 2024). The partnership between Ukraine and NATO/EU defence industries is a step in the right direction to address this issue. In the second section, the three main lessons that the EU can learn from the Ukrainian experience have been illustrated. First of all, the importance of autonomy in specific capabilities such as missile production and technology should be an incentive for European decision-makers and arms manufacturers to address the EU's current gaps in this area. Secondly, innovation plays a crucial role in modern warfare, which means that the EU must increase its efforts in the research and development of new technologies, such as drones, to maintain a technological edge against its adversaries. Finally, the quality of military equipment must be balanced by a sufficient volume to satisfy the armed forces' needs. The EU should incentivise mergers of European defence companies to create entities capable of delivering modern equipment in sufficiently large quantities. While these goals might seem difficult to achieve, the EU has enough resources to be successful, provided that it can reach political consensus on the matter.

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