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Research Report

Fit for war in decades: Europe's and Germany's slow rearmament vis-à-vis Russia

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KIEL REPORT

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Katelyn Bushnell, Ivan Kharitonov

Fit for war in decades: Europe's and Germany's slow rearmament vis-à-vis Russia



No. 1 September 2024

ABSTRACT

War is back in Europe and as it becomes long-lasting, the question of armament gains central importance. This report finds that Russian military industrial capacities have been rising strongly in the last two years, well beyond the levels of Russian material losses in Ukraine. Meanwhile, the build-up of German capacities is progressing slowly. We document Germany's military procurement in a new *Kiel Military Procurement Tracker* and find that Germany did not meaningfully increase procurement in the one and a half years after February 2022, and only accelerated it in late 2023. Given Germany's massive disarmament in the last decades and the current procurement speed, we find that for some key weapon systems, Germany will not attain 2004 levels of armament for about 100 years. When taking into account arms commitments to Ukraine, some German capacities are even falling. The new Tracker provides detailed information on quantities, value of the orders, predicted delivery dates, as well as the companies from which Germany procures. The situation of slow and insufficient procurement can and needs to be remedied. Failing on deterrence would mean a higher likelihood of a costly war. Instead of Germany pursuing a "war economy", as some have argued, Germany's defence budget needs to durably and credibly increase. Higher and credible long-term demand will lead to increasing supply capacities. A long-term European armament strategy is needed. Germany and Europe need to focus on speed in procurement, on cost effectiveness through economies of scale in an integrated European market, on innovation, and on technological superiority. Tracking military rearmament is essential to the security of the continent.

JEL Codes: H41, H56, H60, L64, N44

Keywords: Defence, Armament, Weapon industry, Budget, Germany, Europe, Russia

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LIST OF ABBREVIATIONS

AC	Army Corps
ASD	Aerospace, Security and Defence Industries Association of Europe
APC	Armoured personnel carrier
CAA	Combined Arms Armies
EW	Electronic warfare
HIMAR	High mobility artillery rocket system
IFD	Infantry fighting vehicles
IISS	Institute for Strategic Studies
IMV	Infantry mobility vehicle
LRHW	Long-range hypersonic weapon
MBT	Main battle tanks
MLRS	Multiple launch Rocket System
MRAP	Mine-resistant ambush-protected vehicles
ORBAT	Order of battle
SAM	Surface-to-air missile
SHORAD	Short-range air defence
SIPRI	Stockholm International Peace Research Institute
TOE	Tables of organisation and equipment

FIT FOR WAR IN DECADES: EUROPE'S AND GERMANY'S SLOW REARMAMENT VIS-À-VIS RUSSIA

**Guntram B. Wolff, Alexandr Burilkov, Katelyn Bushnell,
Ivan Kharitonov**

EXECUTIVE SUMMARY

Since the full-scale attack of Russia against Ukraine in February 2022, the war in Europe has become the dominant challenge for European societies – and will remain so for some time. Both failing to provide adequate support to Ukraine to win the war, as well as failing to build-up sufficient military capacities to deter Russia from further aggressions, would leave the continent and the entire Western alliance at a major strategic disadvantage for decades to come. European responsibility for the support of Ukraine and for deterrence will only grow as the United States gets more absorbed in Asia and with domestic politics. The build-up of European armament and in particular Germany's military capacities will become decisive for the future of the continent. A rejuvenated European defence industry can yield the capabilities for a robust defensive posture on NATO's eastern flank. Unlocking the efficiencies of a more integrated European defence market, multinational innovation, and Europe-wide procurement would generate European forces more than capable of matching the Russian military.

The report starts by framing the problem of Russian defence production, which sustains the war in Ukraine and enables a confrontation with NATO. Thus, Chapter 2 **assesses Russia's defence industry** by computing the industrial output that is necessary to supply the Russian forces in Ukraine with adequate ammunition and replace losses of weapon systems to maintain their combat effectiveness. Furthermore, the chapter's assessment accounts for new units that were created by Russia in May 2023 and will be combat effective and ready to deploy by October 2024. Production for the key systems in ground warfare, which are tanks, armoured vehicles, artillery, and mobile air defence, has surged through 2023, and is likely to sustainably continue at an elevated tempo far exceeding European production. Russia currently relies on refurbishing large Soviet-era stocks, and weapon production will eventually slow down when these stocks are empty. The precise moment of this depletion is unknown, although it will not be before 2026. Meanwhile, Russian production capacity has substantially increased and continues to do so, including for newer post-Soviet systems. The experience of the war shows that the systems analysed remain essential to victory in war, including in a hypothetical conflict on NATO's eastern flank. The case of ammunition is broadly similar. Access to the North Korean industrial base has enabled Russian forces to attain a sustainable daily firing rate of 10,000 shells and rockets. Finally, production of drones and loitering munitions has surged, which is

particularly concerning as NATO air defence and counter-drone coverage remains highly fragmented on the eastern flank.

This report's second major chapter summarises the **stock of key military equipment in Germany, France, United Kingdom, and Poland** based on data from the Stockholm International Peace Research Institute and the International Institute for Strategic Studies. It documents a very substantial decline in capacities from the 1990s to 2021 for the six main weapon categories, particularly in Germany. For example, while Germany had around 4000 main battle tanks (Leopard 1 & 2) in 1992 and still 2400 in 2004, that number declined to a mere 339 in 2021. The number of artillery howitzers, now a key daily weapon in Ukraine, fell dramatically from more than 3000 to a mere 120. The number of combat aircraft also more than halved. The data document how substantial cuts in defence budgets during the last thirty years of "peace dividend" have translated into a major decline in stocks and a military force structure that lacks mass and resilience, and that would therefore be rapidly rendered combat ineffective in an attritional peer conflict as is amply demonstrated on the Ukrainian battlefield.

The following section introduces the findings from an entirely newly-build database on Germany's military procurement from January 2020 to July 2024. The *Kiel Military Procurement Tracker* covers all new procurements published on the websites of the German ministry of defence and reveals an increase in equipment purchases. From January 2020 to July 2024, we identify 187 orders covering 221 items worth a total of €137.6 billion. Between March 2022 and July 2024, we identify 122 orders covering 148 items worth €89.9 billion. Yet, the increase in purchases starts to be significant only as of late 2023. Moreover, it is too small to fill the capability gaps that have emerged since 2004 in a reasonable amount of time. For example, until July 2024 Germany ordered only 18 main battle tanks and they were only replacements for those delivered to Ukraine. With a new order of 105 tanks in July 2024, the gap to the 2004 number of battle tanks still amounts to almost 2000. When it comes to artillery howitzers, only 22 Panzerhaubitze 2000 (PzH 2000) were ordered, and all as replacements for those sent to Ukraine. There has not yet been any order of MLRS, despite the high effectiveness demonstrated in Ukraine of both the HIMARS and its Russian counterpart, the Tornado-S. The most significant build-up is perhaps in combat aircraft, where Germany ordered 35 F35 fighter jets soon after the start of the war.

The table below (Table 1.1) summarises the time it would take Germany to reach 2004 level of armaments as well as the time Russia needs to produce Germany's 2021 stocks of main weapon systems at current Russian production rates. When taking the speed of ordering of the last two and a half years, it would take more than 10 years for Germany to reach the number of combat aircraft it had in 2004 and over 40 years for main battle tanks. Most strikingly, the 2004 levels of howitzers would only be reached after 100 years.

Major weapon types: theoretical year of replenishment of 2004 stocks in Germany, current procurement rates and recent stocks in relation to Russian production¹

Weapon Type	2004 Stocks	2021 Stocks	Avg. Yearly Orders	Replenishment Year	Months for Russia to reach Germany
			Feb 2022–Jul 2024	Return to 2004 stocks	July 2024 production rate, 2021 stocks
Combat Aircraft	423	226	14.0	2038	N/A
Main Battle Tank	2,398	339	49.2	2066	2.6
Infantry Fighting Vehicle	2,122	674	77.2	2043	4.0
Other Armoured Vehicle	3,646	2,067	770.0	2026	6.6
Artillery Howitzer	978	121	8.8	2121	3.2
Air Defence (Anti Aircraft)	N/A	12	6.0	N/A	3.0

Note: for more details, please see Chapter 1.

The new database also reveals trends in military spending across weapon systems, the expected delivery dates, and the companies from which the weapons were ordered. For example, we find that 26% of the orders Germany placed since February 2022 are exclusively from **foreign producers**. We also find a substantial **shift in priorities from sea and air forces to procurement for land forces**. We observe that the share of unknown delivery dates has been rising, suggesting that production delays may be increasing.

Finally, the new database allows tracing the orders to **three different German budget vehicles**: the regular defence budget, Einzelplan 14; the budget line in support of partner countries (in particular Ukraine), Einzelplan 60; and the so-called Sondervermögen, a €100 billion debt fund that Germany created in 2022 to purchase military equipment. We find that, compared with the years 2020–2021, spending for defence equipment from the regular budget (Einzelplan 14) has fallen in the last two and a half years as purchases were shifted to the Sondervermögen. This is especially the case when looking at purchases for land forces as Einzelplan 14 purchases post-February 2022 are effectively half of what they were pre-February 2022. A more detailed look into the **German budgetary developments** of Einzelplan 14 shows that in the last two years, parliamentary commitments for future spending on defence equipment (Verpflichtungsermächtigungen) have increased. However, the data indicate that in 2023 future commitments, in particular for the longer term beyond a time horizon of three years, have been falling, which suggests that the political system was hoping for a rapid end of the war and no long-term responsibility to increase military capacities. The medium-term budget planning does not foresee a systematic increase of Einzelplan 14 over the next several years but rather a sudden and politically uncertain increase in 2028.

The **ambiguous messages on future spending, both in 2023 as well as in the current medium-term budget planning**, create uncertainty for the weapons industry that **hinders the build-up of industrial capacities** for military production. It also stands in stark contrast to the determined Russian commitment to industrial warfare that started in late 2022. In defence as much as elsewhere, **demand will create supply**. A credible long-term budget increase will be a much more

¹ The data in this table differs slightly (1 to 3 weeks) from the data presented in the press release accompanying the launch of the report. This discrepancy is due to the report including one extra month of data on Russian production.

efficient, cost-effective, and society-wide acceptable approach to solving inadequate defence capabilities than moving towards a planned-economy-type “war economy” as has been suggested.

Two and a half years into the war, the military capacity gap between Germany and Russia remains large and may even be growing further in Russia’s favour. The need to increase capabilities will only grow as the US experiences domestic political uncertainty and challenges in balancing global commitments in multiple theatres. European and in particular German policy-makers must urgently address their insufficient budgetary commitments; increase the number of ordered units to reduce the costs per unit; invest in military technology and innovation; and overcome excessive local industrial policy that comes at the expense of scale, price, and effectiveness. Procurement models need to be reviewed as soon as possible. We argue that a long-term European and German armament strategy is urgently needed.

1 INTRODUCTION

Europe must confront the reality that a long-lasting war of attrition is again on European soil. The war of Russia against Ukraine is now in its third year and many military experts expect it to last even longer. While initially the hope was that this war would be a short military confrontation, it is by now clear that it has turned into a long-lasting war of attrition. In a war of attrition, three factors are of central importance to its outcome: (1) the political willingness to sustain the war; (2) the production capacities to deliver the necessary military materiel for force sustainment and generation (alongside the ability to recruit and train soldiers, a topic not further considered here); and (3) the available fiscal resources and the cost of the purchased equipment.

As the war lasts longer, the United States is increasingly likely to become absorbed by other threat theatres and European responsibility for the support of Ukraine and for deterrence will grow. In this war of attrition, the build-up of European military capacity for deterrence, as well as the production of military stock at reasonable prices, will thus become more and more decisive. Germany's actions and decisions could play the pivotal role as it is the largest European economy with the most fiscal resources and the greatest industrial base for the production of arms in the EU and Western Europe.

This report analyses the state of key European countries' and in particular Germany's military equipment stocks and the procurement and budgetary funds made available to strengthen them. In particular, we start by taking stock of military equipment and then create a new database that summarises procurement of key weapons before turning to budget questions. Procurement is not delivery. We also document, where possible, the planned delivery dates of the new procurements and find that for many projects it takes years before ordered items are delivered.

Meanwhile, Russia's military-industrial complex is on the rise. According to the US's highest-ranking officer in Europe, General Cavoli (Cavoli, 2024), Russia is *"on track to produce or refurbish over 1,200 new main battle tanks a year, and to manufacture at least 3 million artillery shells or rockets per year – over triple the amount the US estimated at the beginning of the war – and more ammunition than all NATO combined."* Any European strategy on rearmament needs to start by assessing the quantities and capabilities of Russia. Our analysis in Chapter 2 uncovers a massive increase in Russian production capabilities during the war. Given Russia's stated objective of being able to match NATO in military power, this dramatic increase is likely to continue even after hostilities cease. Using an innovative methodology for key weapons systems, we find for instance that Russia sustainably produces or refurbishes to a modern standard up to 130 tanks per month. Production across other key enablers of ground warfare, such as infantry fighting vehicles (IFV), and gun (howitzer) and rocket (MLRS) artillery, has similarly surged. Meanwhile, the deepening relationship with North Korea has unlocked the substantial North Korean industrial base, with significant implications for Russian shell consumption. NATO integrates airpower to a greater degree than Russia, which favours massive use of artillery. Therefore, access to North Korean shells and rockets substantially enhances Russian combat effectiveness.

While sanctions have had some impact on limiting military production, they are currently not sufficiently enforced to substantially reduce Russian production. Our finding that weapon production has been increasing coincides with that of Hilgenstock et al. (2024), who show that Russia has again sufficient access to the technology it needs from Western companies despite sanctions. Access is guaranteed by major new distribution channels through third countries, including China, countries in Central Asia, and elsewhere. The technology sanctions and export restrictions initially led to a short period of significant capacity drops (Rácz et al., 2023), followed by a recovery in capacity. Furthermore, in a longer timeframe Russian industrial policy emphasises self-sufficiency in machine tools and microchips, which will likely lead to a greater degree of decoupling of Russian defence production from Western supply chains.

In Europe, thirty years of budget savings on defence, the so called “peace dividend”, have left substantial gaps in military capabilities in Germany and other countries. After Russia's invasion of Ukraine in late February 2022, German Army Inspector Alfons Mais conceded that the Bundeswehr “more or less stands bare” (Straub, 2022). This bleak reality is a result of substantial budget cuts over many years. Public budgets for defence fell from 2.4% in 1989 to around 1.3% of GDP in 2015 in the EU as a whole (see Figure 1.1). Germany, for example, benefited from a peace dividend that has been estimated to be €419 billion during 1990–2018 (Bardt, 2018), or even as high as €600 billion according to some accounts (Röhl et al., 2023). For the EU as a whole, the European Commission argues that if all EU countries had spent 2% of GDP since the start of the euro on defence, the EU would have spent an additional €1300 billion on defence.² With falling defence budgets, equipment spending was squeezed and reached just slightly above 0.2% of GDP around 2015 and has since increased to close to 0.5% of GDP. These unspent funds have left deep scars in Europe's military equipment and industrial structures.

One immediate consequence of the squeezed defence budgets has been a reduction in the size and capabilities of the defence industry. In 2021, the size of the European defence industry amounted to between €70–110 billion in turnover.³ According to the Aerospace, Security and Defence Industries Association of Europe (ASD), “funding levels were ... causing a steady decline in the European Defence Industrial Base. Peacetime planning has led to a reduction in industrial production capacities, sometimes to no more than the minimum level needed to sustain the existence of relevant facilities....”.⁴ In Germany alone, the number of employees in the weapons industry fell from 280,000 to 100,000 in the 1990s.⁵ According to Röhl et al. (2023), in 2020 only around 55,500 employees in the defence industrial sector in Germany produced weapons, combat aircraft, warships, and military vehicles with a total worth of approximately €11.3 billion. Both the number of workers and the worth of weapons produced were lower in 2020 than they were in 2015.

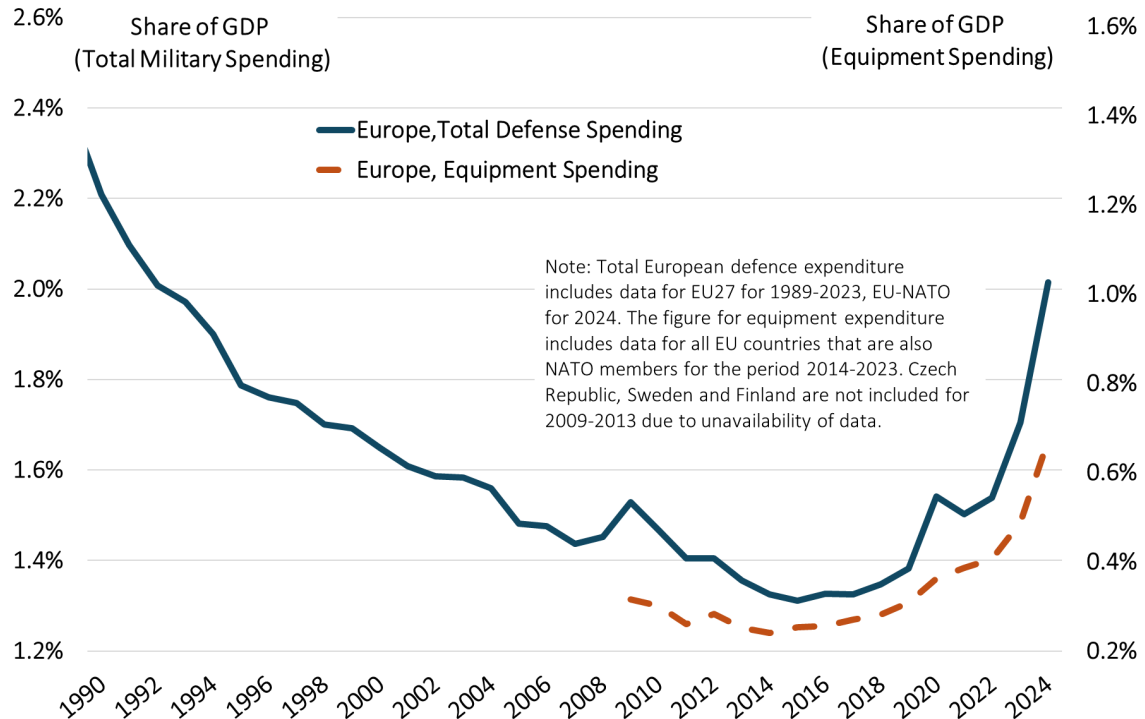
² T. Breton, “Speech by Commissioner Thierry Breton at the European Defence and Security Conference,” European Commission, Brussels (October 11, 2022), https://ec.europa.eu/commission/presscorner/detail/en/SPEECH_22_6119

³ According to the industry association ASD, the industry size is about €118 billion while the Commission's EDIS communication speaks of €70 billion.

⁴ ASD annual report 2022, available at <https://www.asd-europe.org/news-media/publications/asd-reports-publications/facts-figures-2022/>.

⁵ See <https://library.fes.de/fulltext/fo-wirtschaft/00373003.htm>

Figure 1.1:
Defence spending in Europe (left scale) and spending on military equipment (right scale) in percent of GDP



Note: Defence expenditures are nominal SIPRI military expenditure data normalized by nominal World Bank GDP. Equipment spending reflects the sum of national equipment spending over the sum of GDP of the countries shown. Equipment spending is calculated at the country level using NATO share of equipment spending data combined with SIPRI nominal military expenditure data. Equipment spending figure includes data for all EU countries that are also NATO members for the period 2014–2023. Czech Republic, Sweden and Finland are not included for 2009–2013 due to unavailability of data.

Source: Own calculations, based on NATO, Stockholm International Peace Research Institute (SIPRI) and World Bank data.

Starting in 2015 and accelerating with the full Russian attack against Ukraine in 2022, defence budgets have been rising and with them the amounts spent on equipment. The increase in defence spending in the EU has amounted to around 0.7% of GDP since 2015. That increase meant equipment spending could also rise and allowed countries to procure more weapons and ammunition. In Germany, the change is particularly noteworthy. The structure of German defence spending prior to 2022 was heavily tilted towards personnel and other spending, while spending on military equipment procurement only amounted to around 12–15% of defence spending in the last decade. Only after Germany changed its constitution to create a special debt vehicle (the “Sondervermögen” fund), following a speech on February 27, 2022 by Chancellor Scholz to announce a “Zeitenwende”, a turning point, did equipment spending rise substantially.

Germany fulfils the NATO target with 2.12% of GDP on defence spending in 2024. However, the German core defence budget has remained flat or even fallen in real terms and the special fund will run out by 2026 or 2027, leaving a substantial gap in Germany’s defence budget. Germany’s special fund was originally created to supplement the regular budget that was supposed

to reach 2% of GDP by itself. However, the political will to enact such an increase has not been there and the actual budget has even fallen in percent of GDP as it now stands at a mere 1.2%, with the special fund filling the gap to meet the 2% target. The budget gap after 2025 between the regular budget (1.2%) and the 2% goal will thus be very significant, amounting to 0.8% of GDP or more by 2027.

In other European countries, declines in defence budgets were more moderate and there have been increases in the last two years. France currently spends about 2.06% of GDP on defence, which has slightly increased compared to two years ago. The UK has reduced its defence spending from 4% of GDP in the early 1990s to 2.33% of GDP now. Since the end of the Cold War, it thus has spent and continues to spend substantially more than Germany in percent of GDP (Bardt, 2018). Poland has maintained and increased its defence spending substantially from 2.4% of GDP in 2022 to 4.12% in 2024.⁶

How significantly has Germany's Zeitenwende changed the picture and how meaningfully has Germany increased production? In April 2024 an important announcement passed by largely unnoticed outside of narrow industry and union circles: Thyssen Krupp announced its plans to reduce Duisburg steel production capacity and cut jobs.⁷ How could it be that two years into the largest war in Europe since World War II steel production would not be in high demand? After all, following a proposal by Robert Schuman, the EU's founding fathers established the European Coal and Steel Community in 1950, five years after the end of World War II. The EU's founding fathers understood that when European coal and steel markets were under supranational rather than national control, individual European countries would not be able to ramp up their military production and turn weapons against each other. **So how is it possible that demand for steel was so low in April 2024 that German steel production capacity could decline?** Coal and steel markets are obviously driven by many factors and the EU itself is not in a war. Still, the production of military equipment on the continent seems to remain so small that there is no meaningful demand for European steel production.

A systematic analysis of Europe's defence industry and governments, as well as European parliaments and societies' willingness to buy the necessary material, is missing. While the report by the parliamentary commissioner for the German armed forces (Högl, 2024) presents an overview of the still sorry state of Bundeswehr equipment, it does not provide a comprehensive analysis of what is being done to overcome shortages. Two and a half years into the war, have governments ordered sufficient quantities of weapons to ensure deterrence? To answer this question, three of the authors of this report have compiled a new database, the *Kiel Military Procurement Tracker*, that records all publicly announced military purchases from the last several years (Wolff et al., 2024). So far, the database covers Germany, the largest European country with the greatest industrial base, and work on France has started. The dataset is a rich source for anyone wanting to study military purchases.

⁶ According to NATO numbers: https://www.nato.int/nato_static_fl2014/assets/pdf/2024/6/pdf/240617-def-exp-2024-en.pdf

⁷ Farr, E.-V., and Knäckenhoff, T. (2024) "Thyssenkrupp to reduce Duisburg steel production capacity and cut jobs." *Reuters*, April 12. <https://www.reuters.com/markets/commodities/thyssenkrupp-steel-reduce-production-capacity-cut-jobs-2024-04-11/>

For Germany, we document a moderate acceleration in military procurement during 2022–2024 compared to 2020–2021. Yet, despite significant resources committed, the build-up of key weapon systems is slow. Table 1.1 provides a simple thought experiment illustrating how long it would take for stocks to be replenished to 2004 levels given current procurement speed. We take the year 2004 as a reference in order to see how Germany’s military readiness has changed in the last 20 years. Taking earlier years as a reference would distort the picture, since 1990s numbers include military capabilities from East Germany and the Cold War required much larger military stocks than a conflict with a much smaller, post-Soviet Russia. Assume that Germany continued ordering at the pace it has since February 2022 and assume further that all items ordered would be immediately delivered, by which year would Germany reach levels of equipment it last had in 2004? For artillery howitzers, that year would be 2121, and for main battle tanks it would be 2066. Infantry fighting vehicles would only be replenished by 2043, and even combat aircraft, for which a major order of F35s has been placed, replenishment would take until 2038.

Table 1.1:
Major weapon types: theoretical year of replenishment of 2004 stocks in Germany, current procurement rates and recent stocks in relation to Russian production⁸

Weapon Type	2004 Stocks	2021 Stocks	Avg. Yearly Orders	Replenishment Year	Months for Russia to reach Germany
			Feb 2022–Jul 2024	Return to 2004 stocks	July 2024 production rate, 2021 stocks
Combat Aircraft	423	226	14.0	2038	N/A
Main Battle Tank	2,398	339	49.2	2066	2.6
Infantry Fighting Vehicle	2,122	674	77.2	2043	4.0
Other Armoured Vehicle	3,646	2,067	770.0	2026	6.6
Artillery Howitzer	978	121	8.8	2121	3.2
Air Defence (Anti Aircraft)	N/A	12	6.0	N/A	3.0

Note: This table shows the decrease in stocks of major weapon types in Germany between 2004 and 2021; the average rate of procurement of the major weapon types since February 2022; the theoretical year that stocks would return to their 2004 levels provided recent procurement behaviour continues and assuming that orders translate into actual deliveries without major delays; and the number of months it would take for 2021 levels of German stocks to be built up using Russian July 2024 production rates. Infantry Fighting Vehicle orders include both new vehicles and retrofits of existing vehicles. Other Armoured Vehicle orders exclude light tanks. 2021 stocks include long-range anti-aircraft systems. Russian production of Air Defence (Anti-Aircraft) includes medium-range and long-range air defence systems.

Source: Own calculations, based on IISS (2004, 2022); findings of Chapter 2 and methodology detailed in Annex A2; and Wolff, Kharitonov, Bushnell (2024).

Obviously, these dates are only for illustration purposes. First, it is unclear which levels of military readiness Germany should strive to reach. The 2004 numbers have been taken without any military analysis. While the German government has published a broad-ranging national security strategy as well as defence policy guidelines (German Ministry of Defence, 2023), it has not published precise military capability targets, and has instead referred to the NATO 2% goal

⁸ The data in Table 1.1 differs slightly (1 to 3 weeks) from the data presented in the press release accompanying the launch of the report. This discrepancy is due to the report including one extra month of data on Russian production.

and NATO capability targets (German Federal Foreign Office, 2023). Second, the German defence ministry has declared that it wants to speed up procurement (German Ministry of Defence, 2023). Moreover, ramping up military procurement and production takes time, and consequently, the results of any decision can only be seen after many years. While not a given, it may be possible that procurement and production is accelerating.

The last column of the table shows that Russian production is currently so strong that it could easily match the 2021 German stock in weapons in 2-7 months. These numbers point to a **huge capability gap that Germany is clearly not filling at the moment.** The numbers also reveal that the necessity of rapid rearmament is more urgent than what was previously expected. In January 2024, Boris Pistorius, Germany's defence minister, stated that it could be possible for Russia to attack a NATO country within 5–8 years.⁹ If that assessment is correct, then current German procurement speed is inadequate.

A first look into French data suggests that increases in French production have also been limited. The French Ministry of Armed Forces general budget was €67 billion in 2021, €59 billion in 2022, and €64 billion in 2023 (French Ministry of Economics, Finance, and Industrial and Digital Sovereignty, 2024). As of writing, the 2024 budget is not yet officially available. While production of howitzers and ammunition has increased, we show that the numbers remain low compared to the needs in the Ukrainian battlefield.

Small annual equipment spending of €4–14 billion prior to 2021 in the four major Western economies we consider has thus meant three things. **First**, ordered quantities were small and some stocks will only be replenished with long delays. Put simply, Europe's, and in particular Germany's, military equipment stocks are very low. **Second**, small and infrequent orders, combined with restrictive rules for exports of weapons, meant that production capacities for weapons and ammunition have also been low. **Third**, with low quantities ordered, little economies of scale could be achieved and some **costs per unit** were and remain **very high**.

Three examples illustrate the excessively high costs of defence equipment purchases. Germany ordered 600,000 rounds of 30mm autocannon ammunition for Puma infantry fighting vehicles. The cost of this ammunition order is around 576 million euros, which equals almost 1000 euros per shot.¹⁰ With 350 Pumas and theoretically up to 600 rounds per minute, each

⁹ Camut, N. (2024) "Putin could attack NATO in '5 to 8 years,' German defense minister warns." *Politico*, January 19. <https://www.politico.eu/article/vladimir-putin-russia-germany-boris-pistorius-nato/>

¹⁰ Even though a major land war is again raging in Europe, Germany's procurement practices hardly seem to reflect the scope or intensity of the situation. On 2 December 2022, the [German ministry of defence](#) announced the creation of a framework agreement for the procurement of more than 600,000 rounds of 30mm autocannon ammunition for Puma infantry fighting vehicles. The cost of this ammunition is around 576 million euros, which equals almost 1000 euros per shot. According to manufacturer [Rheinmetall](#), the MK30/2-ABM autocannon used on Puma vehicles fires up to 600 rounds per minute. These figures imply that if these guns were needed to shoot at maximum capacity, each minute of fighting would cost the Bundeswehr close to 600,000 euros. Furthermore, the procured ammunition would only last 1000 minutes, or just under 17 hours. In essence, Germany purchased over half a billion euros worth of ammunition that costs over half a million euros per minute of maximum use and would not even last a few days of heavy fighting – not quite the meaningful preparation for serious wartime combat we all expect to see.

Puma receives enough to shoot some three minutes or a few days under normal battlefield conditions. Another example: last year Germany and the Netherlands ordered Rheinmetall's Caracal, a light assault vehicle jeep based on the Mercedes G class. The framework agreement included jeeps for Ukraine and cost a whopping €1.9 billion for 3058 jeeps¹¹. A unit cost of €620,000 per jeep is clearly expensive and suggests low economies of scale. A third example is the seven-year framework agreement for almost 200,000 headsets at a price of €2100 each with a total value of €400 million¹². Initially, the plan was to continuously procure and use 200,000 headsets until 2051 for a total of €2.8 billion. While good quality headsets with noise cancellation and speaking functions can be expensive, the unit cost, let alone the initial cost of the entire project, were so excessive that the German court of auditors critiqued them in a report.¹³

A number of reports have highlighted that the European defence market remains fragmented – and that as a result orders are in small quantities and at high prices and key weapon systems are not supplied. For example, European Commission and High Representative of the Union for Foreign Affairs and Security Policy (2024) bemoan the fragmentation and call for more intra-EU trade in defence products as well as re-directing demand for equipment to EU markets, thereby reducing reliance on imports. Wolff (2024) critiques the import targets and the embedded protectionism of the report and Mejino-Lopez and Wolff (2024) cast doubt on the numbers of the Commission analysis. The Letta report (Letta, 2024) equally calls for greater defence market integration as a way of ensuring efficiency. Restrictive export rules further reduce market sizes and thereby increase unit costs, and differences across EU countries render market integration more difficult (Sauer, 2019). Finally, as Röhl et al. (2023) note, *“no European country – not even Germany with its broad-based defence industry – has on its own a comprehensive portfolio of defence production technology capabilities in aerospace systems, land warfare, naval vessels, and cyber defence. At the European level, the full spectrum of capabilities is available, but countries pursue industry-related particular interests, which hinders interoperability and the deepening of independent European defence capabilities”*. Crucially, Russia does not face such issues, as it enjoys a highly centralised portfolio of state-owned defence enterprises that is augmented by a startup-driven innovation ecosystem.

¹¹ <https://www.ft.com/content/0df492cd-dcbc-4251-9854-a724bdcfd30d> and Rheinmetall, “Deutschland und Niederlande bestellen Luftlandfahrzeuge bei Rheinmetall – Rahmenvertrag über 3.058 Fahrzeuge im Wert von 1,9 Mrd EUR abgeschlossen,” (July 10, 2023), <https://www.rheinmetall.com/de/media/news-watch/news/2023/07/2023-07-10-rheinmetall-grossauftrag-fuer-luftlandeplattform-caracal>

¹² See Rheinmetall “Taktische Kommunikation der Bundeswehr: Rheinmetall gewinnt Rahmenvertrag mit möglichem Auftragswert von 400 Mio EUR,” (April 24, 2024), <https://www.rheinmetall.com/de/media/news-watch/news/2024/04/2024-04-24-rheinmetall-gewinnt-rahmenvertrag-sprechsatz-mit-gehoerschutzfunktion>

¹³ Tagesspiegel, „Der Auftrag sei unwirtschaftlich: Bundesrechnungshof rügt offenbar geplanten Milliardendeal für neue Soldaten-Kopfhörer,” (February 08, 2024), <https://www.tagesspiegel.de/politik/der-auftrag-sei-unwirtschaftlich-bundesrechnungshof-rugt-offenbar-geplanten-milliardendeal-fur-neue-soldaten-kopfhorer-11181190.html>

The microeconomics of defence procurement may be a further reason for excessive costs. The scientific advisory board of the German economics ministry, German Ministry for Economic Affairs and Climate Action (2023), identifies a number of microeconomic issues that need to be addressed to accelerate procurement and make it more cost-effective. In the board's view, issues related to slow and expensive procurement include excessive parliamentary oversight over individual purchases, which can lead to pork barrel politics; administrative hurdles that prioritise the protection of small and medium enterprises (SMEs); contract designs that lack incentives for defence companies; as well as insufficient innovation in general. Streb and Streb (1998) argue that incentive compatible contracts designed in the spirit of Laffont and Tirole (1986) were central to the success of Nazi Germany's armaments miracle after Albert Speer initiated them in 1941.

An important question we explore in this report is how should Europe address the substantial supply bottle necks that hinder defence production? The focus of the report is on the demand side: have countries and in particular Germany started ordering more substantial quantities since the beginning of the war in Ukraine? Has Germany done so in a way that companies would be reassured about future demand? In our view, **a key problem of increasing military supply is the uncertainty about future demand.** Companies might see that current high prices represent an opportunity to invest in production capacity. Yet the usual investment cycle in the context of defence production faces two obstacles. First, if too many companies react to the high price signal today and invest, there may be overcapacity tomorrow that leads to excessively low prices and makes the investment ex-post unprofitable. Second, the usual "pork cycle" problem is compounded by the fact that demand for defence products is limited to governments. Accordingly, overproduction cannot even be absorbed by other customers, especially when there are export restrictions. At the same time, governments and especially **Germany has been and remains hesitant to credibly commit to future military spending, as we show in detail.**

Financing obstacles of defence companies has been identified as a further obstacle to military production. Anecdotal evidence points to the fact that banks were restrictive in providing credit to defence companies, at least prior to the invasion (Prem, 2022). Yet, since the start of the invasion, the stock prices of defence companies have increased substantially, suggesting that at least the listed companies in Europe should be able to secure funding. Federle et al. (2022) find that the stock prices of companies closer to the Ukrainian border dropped more than those of companies that are further away. Interestingly, the opposite holds true for defence companies: the closer a defence company is to Ukraine, the higher its stock price rose. This observation suggests that markets automatically price in increasing defence expenditure the closer a country is to a war zone while they price in a military disaster risk for all other companies.

A significant concern is whether European militaries are keeping up with the speed of innovation, for example in drone warfare, that is now visible in Ukraine and Russia. Military analysts report on the rapid speed of innovation in the battlefield. In his April 2024 testimony to Congress, US General Cavoli highlighted that Russia, after initial failings and inability to learn, has now managed to transform its army into a learning organisation (Cavoli, 2024). That Russia now learns from and corrects past mistakes makes the Russian threat much greater and raises the question whether European armies that are not currently fighting as well as their suppliers are

able to adapt to the ever-evolving warfare situation. Satellite constellations such as Starlink are fundamental to modern warfare, especially in conjunction with AI-enabled battlefield management systems. Drones, sea drones, hypersonic missiles, electronic warfare, cyber capabilities, AI-enhanced systems, and small and agile weapons systems are increasingly prominent. French General Schill (Ruitenbergh, 2024) predicts that countermeasures will eventually mitigate the ability of cheap drones to destroy expensive systems such as tanks and even warships. Developing such countermeasures will be wholly dependent on intense innovation in electronic warfare and directed energy weapons. While the use of AI and drones has allowed Ukrainian forces to remain resilient in 2024 despite shortages of heavy weapons and munitions, it has also come at the cost of high Ukrainian casualties. For European defence innovation, this means that it is vital to invest in many types of systems and generate innovation across the entire defence ecosystem. **Overall, technological innovation should be a priority for European defence.**

Defence spending is not a zero-sum game. Wars are more costly than deterrence. The Latin expression, “*Si vis pacem, para bellum*”, remains true. Failed deterrence and growing likelihood of an expansion of the war would not only have major economic costs easily exceeding the costs of defence investments. They would also mean an increased risk of NATO countries having to directly engage in fighting and risking the lives of citizens. Moreover, there is substantial evidence that **defence spending on military technology can trigger innovation that benefits all sectors of the economy**, thereby boosting GDP. The war in Ukraine is a powerful testimony to innovation in the battlefield and documents the need for Europe’s militaries to advance their innovation strategies. On the whole, economising on defence spending in the current situation would not only undermine security but also put Europe’s long-term growth prospects at a disadvantage.

The main aim of this report is to provide policymakers and the public with the factual information to be able to accurately assess the challenge that confronts them. The report paints a gloomy picture of surging Russian capabilities as well as limited military stocks in key European countries and inadequate procurement. Continuing like Europe has in the past two and a half years would be a highly risky strategy. However, with more forceful political decisions and greater fiscal commitments, it is possible to rejuvenate European defence production and sufficiently generate European forces to be able to match and deter the Russian military on NATO’s eastern flank. The last section therefore draws some key policy conclusions and develops recommendations for how to proceed. *Provocatively, the report thus has three consecutive sections: first, what is the external threat, second, how we messed up the past couple decades, and third, how we messed up the past couple years.*

2 RUSSIA'S STRENGTHENING DEFENCE-INDUSTRIAL COMPLEX¹⁴

European defence production and the European defence industrial ecosystem do not exist in a vacuum. Russia is and will remain the most acute security challenge for Europe. With the return of industrial warfare to European battlefields (Vershinin, 2024), assessing Russian defence production is critical. The war in Ukraine is an attritional, industrial war, where victory is determined by force generation and sustainment, and therefore by production rates. After months of subpar performance in 2022, the Kremlin wholly committed to systematically prosecuting the war that autumn, surging production and therefore force generation and sustainment. Beyond the war, the surge in Russian production since 2022 will translate into a larger, better equipped, and experienced post-war Russian military, as well as a surge of exports to regimes unfriendly to the West, especially in the so-called “global South”. As a warning sign, the crisis in the Red Sea acutely demonstrates the impact of hostile actors that acquire substantial arsenals of capabilities once reserved for powerful states.

Methodology

This chapter is based on a novel methodology for estimating Russian production in key systems, such as tanks and artillery, and key munitions, such as shells and long-range drones. The chapter assesses production from October 2022 on. This moment is when the Kremlin, first with mobilisation, committed itself fully and systematically to prosecuting the war as a lengthy industrial war. Since then, Russian forces in Ukraine have gradually grown and, most critically, are continually replenished with weapon systems and personnel so that they remain combat effective. The result of this gradual change is directly reflected in Russian performance: the capture of Bakhmut in May 2023, the defeat of the 2023 Ukrainian summer counteroffensive, the capture of Avdiivka in February 2024, the reduction of the Ukrainian bridgehead over the Dnieper in Kherson, and the ongoing summer 2024 offensive in the Donbas. Russian forces would not be able to sustain this tempo of operations without continual reinforcements.

The methodology of the chapter begins by cataloguing which Russian units are fighting in Ukraine at any given month since October 2022, which is the Order of Battle (ORBAT) of the Russian campaign. Taking the composition of the Russian armies in Ukraine in terms of brigades and regiments, and then further breaking down those units into their constituent battalions, gives us the total count of battalions of each type (motor rifle, tank, artillery, etc.) in theatre. In turn, taking the standardised tables of organisation and equipment (TOE) of each battalion type gives us the total maximum possible number of each system in theatre.

The monthly attrition rate of Russian forces corresponds to well-established benchmarks for post-World War II conventional warfare (Dupuy, 1995; Epstein, 1988). Therefore, we can estimate the monthly production rate needed to maintain the combat effectiveness of all Russian formations by taking the percentage of systems per battalion that would be attritted every month. Furthermore, Russia created three new armies in May 2023: the 25th Combined Arms

¹⁴ This chapter was primarily written by Alexandr Burilkov, Leuphana University Lüneburg.

Army and the 40th and 44th Army Corps. We estimate the monthly production rate needed to make them combat effective by no later than October 2024.

One final benchmark for production are Russian exports. Defence exports have always been, and will continue to be, an important element of Russian foreign policy (Bergmann, 2023). However, sustaining Russian forces fighting in Ukraine, and generating new forces for the Russian military, takes priority for Moscow over exports. Therefore, we can assess whether production for various types of weapons systems is sustainably stabilised by looking at the fulfilment of existing pre-2022 orders, and new orders signed since 2022. Further details of the methodology are presented in Annex A2.

Production

Production has strongly increased across all weapon systems since Q4 2022. Table 2.1 outlines overall production rates for the typical systems in ground warfare per quarter. Production includes both new hulls and retrofits, as T-72 and T-80 tank production lines have been restarted. Though it is estimated that 80% of production still draws on retrofits, which may have implications for production tempos from 2026 on (Watling and Somerville, 2024). We explore the balance between new and retrofit in the relevant sections. Shells are not included in the table but are discussed further down as well. Finally, we include data on the production of the Lancet series of long-range loitering munitions, due to their demonstrated high effectiveness in striking Ukrainian assets, especially artillery, air defence, and even aircraft deep in the rear at ranges up to 70 km.

Table 2.1:
Russian quarterly production of key weapon systems

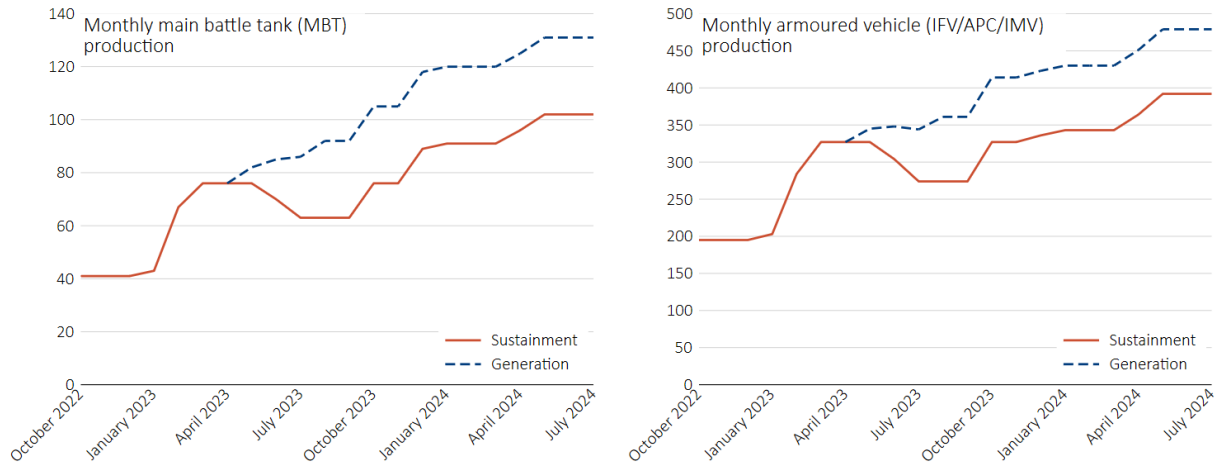
Quarter	Tank (MBT)	Other armoured vehicle (IFV/APC/IMV)	Artillery (gun)	Artillery (rocket MLRS)	Short-range air defence (SHORAD)	Medium and long-range air defence	Lancet loitering munition
Q4 2022	123	585	45	15	9	6	93
Q1 2023	186	814	62	23	11	8	128
Q1 2024	360	1290	102	36	27	12	440
Q2 2024	387	1409	112	38	27	12	535
<i>Increase</i>	<i>215%</i>	<i>141%</i>	<i>149%</i>	<i>153%</i>	<i>200%</i>	<i>100%</i>	<i>475%</i>

Note: The Other armoured vehicle (IFV/APC/IMV) category can be broken down as roughly 35% infantry fighting vehicles and a fluctuating balance between armoured personnel carriers and infantry mobility vehicles depending on unit requirements, with regular units being allocated armoured personnel carriers, while lighter units such as special forces and reconnaissance receive infantry mobility vehicles.

Source: Own calculations, based on methodology detailed in Annex A2.

Monthly production rates fluctuate significantly since October 2022 but have a clear upward trend. Each graph in Figure 2.1 shows two different lines summarising the production needed for the *sustainment* of forces in Ukraine and for the ongoing build-up, or *generation*, of new forces. A strong upward trend is visible. Importantly, as of April 2023, production rates have surpassed the needs in Ukraine and allowed Russia to build major new fighting units.

Figure 2.1:
Frontline systems: tanks (MBT) and other armoured vehicles (IFV/APC/IMV), estimated monthly production



Note: The red solid Sustainment line shows the production rates needed to keep Russian units at combat efficiency, given the units in theatre and the nature of the fighting. The blue dashed Generation line shows the extra production rates needed to fully equip the three new armies (25th Combined Arms Army and the 40th and 44th Army Corps) created by Russia in May 2023 within a reasonable timeframe (18 months), so that these formations are combat effective by October 2024.

Source: Own calculations, based on methodology detailed in Annex A2.

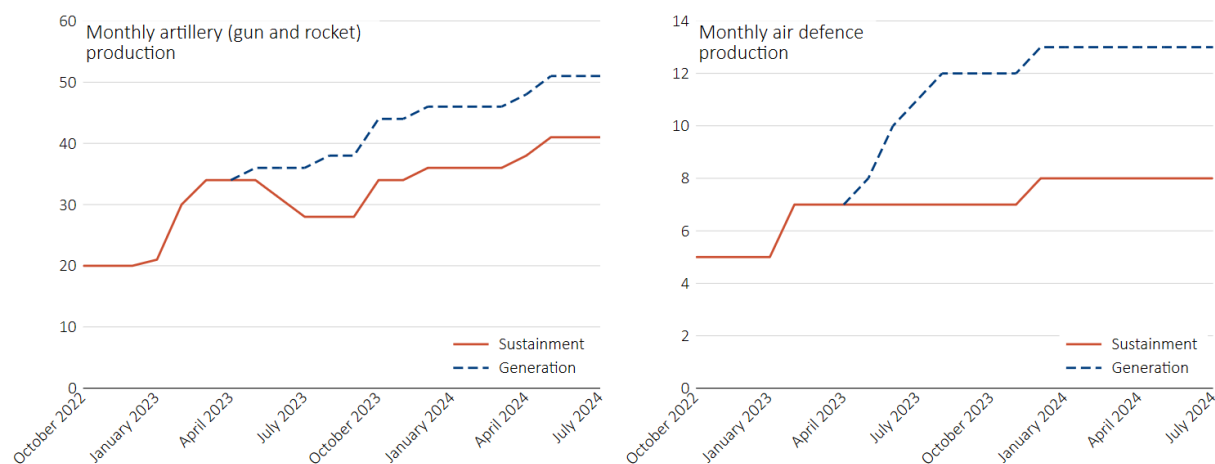
Frontline systems remain crucial for ground warfare, especially for offensive operations, where the protection provided by armoured vehicles (IFV/APC/IMVs) to infantry is critical for infantry to be able to attack effectively. Moreover, the combination of firepower and protection offered by main battle tanks (MBTs) remains unmatched on the battlefield, despite persistent and mistaken rumours of the demise of the tank (Lee, 2022). Without plentiful access to these systems, attacking infantry invariably suffers heavy casualties. Russian monthly production for both types of systems has significantly increased to up to 140 main battle tanks and up to 500 other armoured vehicles. Such a significant production rate can sustain and generate forces in excess of any combined European capacity for the time being.

Up to now, roughly 80% of production of armoured vehicles are retrofits of existing hulls from available stockpiles of Soviet and Russian vehicles. Though when stockpiles deplete, production may be less affected than assumed. As stockpiles are depleted, it is expected that the production rate would correspondingly decrease, with estimates that this would begin in 2026 (Watling and Somerville, 2024). Hulls are the key bottleneck in production. Production lines for the widely used T-72 hull for tanks (used by the T-72 and T-90), infantry fighting vehicles (IFVs), artillery, and air defence existed prior to the war and have been expanded. Additionally, there are dedicated production lines for the T-80 tank. For other armoured vehicles, there is a noticeable shift to more modern, cost-effective vehicles like the BMP-3 infantry fighting vehicle (IFV) and the Typhoon armoured personnel carrier (APC). Even without any new production lines, Russian production of new tanks would be at 350 modern tanks per year past 2026, but

additional production lines may be opened. Production of other armoured vehicles will be less affected as shifts to more contemporary wheeled designs are underway.¹⁵

Rear systems have had a similar surge in production to frontline systems (Figure 2.2), but these systems have lower attrition rates which lead to less demand for sustainment. The distance from the frontline at which rear systems operate is negatively correlated to their attrition rate, with shorter ranged systems such as mortars and short-range air defence (SHORAD) being destroyed more frequently than longer range systems such as 152mm howitzers, rocket artillery (MLRS), and medium and long-range air defence.

Figure 2.2:
Rear systems: artillery and air defence, estimated monthly production



Note: The red solid Sustainment line shows the production rates needed to keep Russian units at combat efficiency, given the units in theatre and the nature of the fighting. The blue dashed Generation line shows the extra production rates needed to fully equip the three new armies (25th Combined Arms Army and the 40th and 44th Army Corps) created by Russia in May 2023 within a reasonable timeframe (18 months), so that these formations are combat effective by October 2024.

Source: Own calculations, based on methodology detailed in Annex A2.

Air defence production in particular is significantly higher than in Europe. This fact has significant implications for the effectiveness of Western and Ukrainian airpower as the environment is contested by saturated air defence.

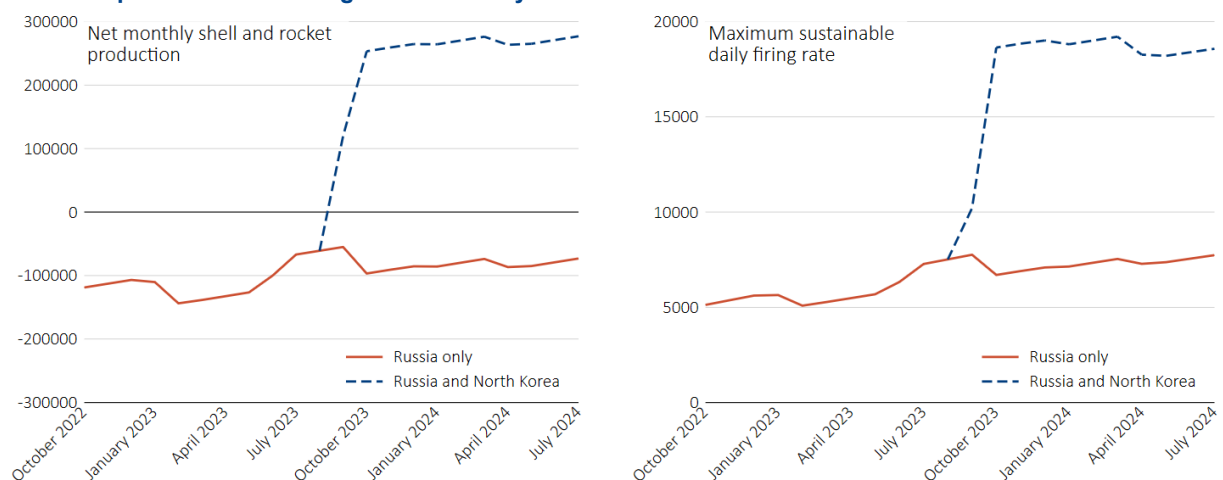
When it comes to rear systems such as artillery and air defence, Russian production is adapting so that reliance on limited stocks is unlikely to cause major bottlenecks in output. Unlike for tanks, where the main production bottleneck is the availability of hulls, the main bottleneck for gun artillery is barrels, which wear down rapidly in battlefield conditions. Russia is introducing modern wheeled artillery systems to remove the reliance on hulls, thus removing competition in production between tanks and artillery. Barrel production, resting on legacy Soviet imports and domestic capacity, is sufficient to meet the demands of Russian forces in Ukraine (CIA, 1982). Nonetheless, as Russian forces rely primarily on artillery in warfare, future issues in consistent shell procurement and demands for greater range and accuracy are likely, leading to a

¹⁵ One precedent is the very rapid production of IMVs (MRAPs: mine-resistant ambush-protected vehicles) by the US during the height of the wars in Iraq and Afghanistan.

shift in the balance between gun and rocket artillery (MLRS). Russia produces several MLRS systems, the most modern of which, the Tornado-S, has broadly similar capabilities to the American HIMARS.

Ammunition shell production and usage show dramatic changes, and Russia now has a strong oversupply thanks to North Korean stocks and production (Figure 2.3). A daily firing rate of 10,000 shells has been frequently invoked as the baseline for Russian forces in Ukraine (c.f. CNN, 2024). For comparison, such a firing rate would deplete German ammunition stockpiles within two days, while current German annual production would enable a maximum of 70 days of such firing rates (Ismar and Schweikle, 2024). However, even with an increase in Russian production to a likely ceiling of between 3 and 3.5 million shells per year (Cavoli, 2024), this daily firing rate is not sustainable and would gradually deplete Russian stockpiles, unless the firing rates were adjusted downward, as the red *Russia only* line in the image on the right shows, which would directly decrease Russian offensive capabilities.

Figure 2.3:
Net shell production and usage sustainability



Source: Own calculations, based on methodology detailed in Annex A2.

However, **deepening cooperation between Russia and North Korea has had a dramatic and immediate impact in ammunition supplies.** By mid-2024 North Korea had supplied up to 4.8 million shells and rockets from its stockpiles and is estimated to have an annual production of 2 million that could be surged to up to 6 million (Choi, 2024). Even considering that a non-negligible proportion of North Korean shells are of poor quality, increased North Korean production represents a significant shift in the Russian supply situation, and is especially relevant for the stockpiling of munitions in preparation for large-scale offensives, where daily firing rates can surge to 60,000 or more. North Korea also supplies a variety of missiles, likely also including the KN-21 ballistic missile, augmenting Russia's sizeable and highly effective arsenal of Iskander ballistic missiles.

Beyond the war in Ukraine, increases in Russian shell production, and corresponding difficulties, delays, and limitations in European shell production, indicate that for any hypothetical

NATO-Russia conflict, it can be expected that Russia will have more than replenished its stockpiles, and have deepened them sufficiently to maintain high daily firing rates for an extended period of time.

Although not analysed in detail in this report, the situation is similarly concerning for other munitions production, such as missiles of all types, precision-guided glide bombs, air defence interceptors, and even the Zircon hypersonic missiles. Data from the war so far shows that Ukrainian air defence has an overall interception rate of 30% for missiles and 66% for drones.¹⁶ Particularly concerning examples include Russian monthly consumption rates of more than 1,000 glide bombs; the increasing tempo of pinpoint strikes by Iskander ballistic missiles deep into Ukrainian territory targeting premier assets such as airbases; and even the demonstrative use of Zircon hypersonic missiles. In all instances, **Russia has surged production, which is very likely to result in deep ammunition stores in peacetime going forward.** That Russia has been able to so quickly deepen its munitions store is an important lesson for Europe. Contemporary conflicts, whether in Ukraine or the Middle East, have conclusively demonstrated that continual access to munitions is fundamental to resilience. It is vital, for instance, in air defence, where interception is limited not only by the technical features of air defence systems, but also by the number of available interceptors as compared to the probable number of hostile drones and missiles. The near-total destruction of the Ukrainian power grid in 2024 acutely demonstrates the consequences of shortages of interceptors.

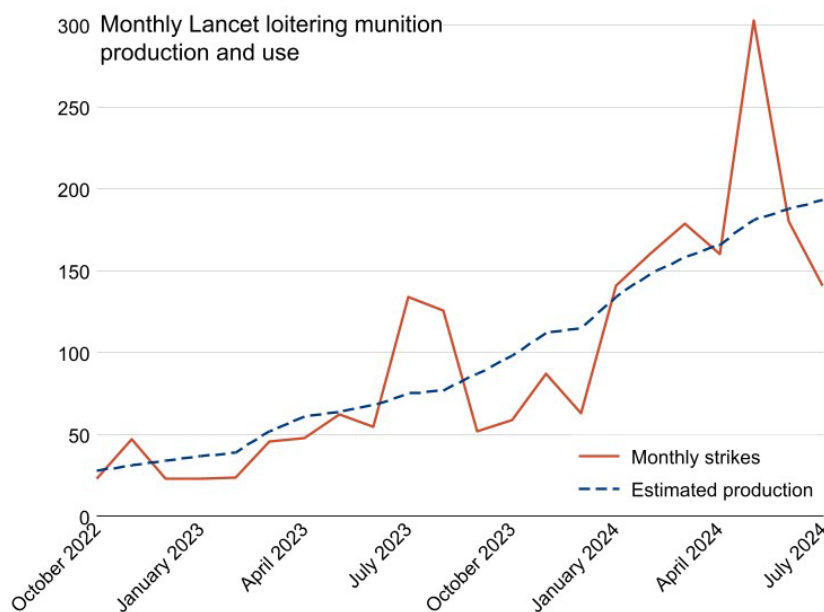
Drones of all types have become essential to contemporary warfare and after Ukraine took an initial lead, Russia has since caught up. Ukraine led in both quantity and quality of drone production in 2022, spurred by an ad-hoc innovation ecosystem. Russia gradually caught up in the quantity and quality of production, including developing its own innovation ecosystem. On the other hand, Ukraine benefits from superior NATO-provided and AI-enabled ecosystem of battlefield management systems networked via Starlink, which are more advanced than similar Russian systems. Small drones have become ubiquitous on the Ukrainian battlefield, with Russian and Ukrainian consumption reaching into the tens of thousands monthly. Nonetheless, both Russia and Ukraine still rely on China for the supply of small drones.

The production rate of the Lancet family of longer-ranged loitering munitions has been rising rapidly and poses a particularly difficult challenge (Figure 2.4). These drones are difficult to detect, can be AI-enhanced, are capable of striking deep into Ukrainian territory (up to 70 km), and have a warhead powerful enough to destroy tanks, artillery, and air defence systems. The combination of Lancet strikes and drone-enabled ballistic missile strikes has had devastating effects on Ukrainian rear systems in 2024. Lancet production is more technically demanding

¹⁶ Sample interception rates for commonly used Russian missiles in 2024: 50% for the older Kalibr subsonic cruise missiles, 22% for modern subsonic cruise missiles (e.g. Kh-69), 4% for modern ballistic missiles (e.g. Iskander-M), 0.6% for S-300/400 supersonic long-range SAM, and 0.55% for the Kh-22 supersonic anti-ship missile. Data on interception rates of hypersonic missiles is scarce: Ukraine claims a 25% interception rate for hypersonic Kinzhal and Zircon missiles, but Ukrainian sources also indicate such interceptions require salvo firing all 32 launchers in a US-style Patriot battery to have any chance to shoot down a single hypersonic missile. By comparison, German Patriot batteries have 16 launchers, and Germany has 72 launchers in total.

than that of small drones, and more closely resembles the complex procedure of missile manufacturing. Therefore, the pace of Lancet production can be considered a proxy for the production of similar systems, such as long-range helicopter missiles. Furthermore, NATO air defence over the eastern flank remains patchy, as do electronic warfare capabilities, where NATO remains a notable laggard. In the event of a hypothetical conflict on the eastern flank, **the saturation of the battlespace with swarms of Lancet type loitering munitions is a serious operational and strategic concern.** Furthermore, **the production surge of these systems will likely continue beyond the cessation of hostilities in Ukraine, and with a reasonable export unit cost of approximately €32,000 will become a much sought after capability by other revisionist actors,** introducing further risk and instability for Western military action.

Figure 2.4:
Lancet long-range loitering drone production and use



Source: Own calculations, based on open-source intelligence.

One final consideration for European rearmament is the hypersonic problem. One characteristic of the war in Ukraine is the mass use by Russia of supersonic and hypersonic missiles.¹⁷ This strategic bombing campaign has depleted Ukrainian air defences, destroyed logistics nodes and command centres, and disabled almost all power plants (Watling and Dolzikova, 2024). Supersonic and hypersonic missiles are distinct from Western subsonic cruise missiles in that they are difficult or even impossible to intercept and are significantly more destructive (RAND, 2017). Beyond the war in Ukraine, the diversification of the Russian hypersonic arsenal is a

¹⁷ Supersonic missiles have a speed greater than 1,470 km/h, and hypersonic missiles a speed greater than 6,100 km/h. At these speeds, a hypersonic missile has far more kinetic energy at impact than a subsonic cruise missile like the *Taurus*, with kinetic energy being a key determinant of the destructive power of a missile, especially for penetration of hardened buildings and fortifications.

significant problem for Europe. It is certain that replenishing and expanding this strategic asset will be a priority for the Kremlin. A sufficiently large stockpile, distributed across aircraft, surface warships, submarines, and ground launchers, opens the possibility of a "decapitation strike" that causes major damage to the other side's military capabilities and infrastructure in the opening phase of a conflict. Given the military asymmetry between NATO and Russia, a devastating first strike has long been part of the Russian toolkit (c.f. Seddon and Cook, 2024). Stockpiling hypersonic missiles would unlock the potential for a conventional rather than nuclear first strike. As there is no near-term defensive solution, a different approach would be the acceleration of Europe's own hypersonic capabilities to provide a measure of mutual deterrence with Russia. One proposed plan is that the US Army will station its own ground-launched LRHW missile system (Long-Range Hypersonic Weapon) in limited numbers in Germany starting in 2026 (Judson, 2024). However, this deployment is politically controversial. Furthermore, American attempts to develop a working hypersonic capability face repeated failures and cancellations (IISS, 2023). Furthermore, the LRHW is an extremely high priority system for the Indo-Pacific. Therefore, **the development of a multinational European hypersonic capability should be a consideration. Such a development can build on existing programmes, which include a number of French projects for hypersonic glide vehicles and Germany's SHEFEX civilian space technology demonstrator, as we discuss in the conclusion.**

3 MILITARY STOCKS IN GERMANY, FRANCE, THE UK, AND POLAND

In this section we present and analyse the stock of existing European military material. We focus on ground forces and air forces, from which we select six types of weapons that best reflect a country's military capabilities. These types are (1) main battle tanks (MBTs), (2) infantry fighting vehicles (IFVs), (3) other armoured vehicles (light tanks and armoured vehicles), (4) artillery (towed and self-propelled howitzers and MLRS), (5) anti-aircraft weapons (towed and self-propelled missile systems and guns), and (6) combat aircraft. These are also the key weapon systems used in Ukraine. Although drones are also used in Ukraine, no systematic data is available to the extent of our knowledge. We select four major European military powers, namely Germany, France, the United Kingdom, and Poland, in order to construct a representative picture of European defence capabilities. This section compiles existing data from the International Institute for Strategic Studies (IISS) and Stockholm International Peace Research Institute (SIPRI) to document available stocks of military equipment as well as the value of these stocks. We also show how military stocks have evolved during the peace dividend years until 2021. In Annex A3, we document the stocks of precise types of weapons, which differ across countries. We show data from shortly after the end of the Cold War (1992), from 20 years ago (2004), from the year before the Russian invasion of Crimea (2013), as well as annual developments from more recent years, 2018–2021. Later data is not available. The data is taken from various IISS Military Balance reports (see IISS 1992, 2004, 2014, 2020, 2021, 2022) and is compiled by us.

Table 3.1 documents a substantial decline in available stocks of key weapon systems across key European countries and in Germany in particular over the last decades. The decline in German numbers over the past 20 years is particularly striking: in 2004 Germany had thousands of tanks and infantry fighting vehicles and even almost one thousand howitzers. By 2021, these numbers had come down to the hundreds, as Germany only had 339 tanks and 121 howitzers. The German numbers for 1992 must be interpreted carefully, as they include weapons and equipment from the newly incorporated East German army. Still, when considering the available Leopard tanks, i.e., the West German tanks, Germany had around 4200. **The German decline in military stock is thus massive.** Also, numbers of various types of military equipment for France have fallen, but less strongly than for Germany, and the French numbers are now quite comparable to the German ones. The same holds for the UK. It is remarkable, however, how few air defence systems the UK currently has – a topic that has recently attracted some controversy.¹⁸ Poland stands out with relatively large numbers of main battle tanks, and in 2021 has more than Germany, France, and the UK combined. Poland also has significantly more howitzers than the other countries. Moreover, even for combat aircraft, the data shows a substantial decline in capabilities in the last decades across all four countries. Finally, air defence equipment is patchy across the board, with some countries such as the UK having worryingly limited capabilities. Overall European air defence capacities are extremely limited, which justifies the

¹⁸ Boffey D. (2024) “UK given stark warning over ‘negligible’ air defence systems.” *The Guardian*, May 12. <https://www.theguardian.com/uk-news/article/2024/may/12/uk-given-stark-warning-over-very-limited-air-defence-systems>

European Sky Shield Initiative¹⁹, a multinational effort to enhance and strengthen European air defence.

Table 3.1:
German, French, British, and Polish Arms Stocks 1992–2021

	1992	2004	2013	2019	2020	2021
<i>Germany</i>						
Main Battle Tanks	6684	2398	322	323	323	339
Light Tanks	118	343	128	175	175	175
Infantry Fighting Vehicles	3250	2122	395	651	710	674
Armoured Vehicles	12977	3646	2114	1933	2067	2067
Howitzers	3214	978	130	121	121	121
Long Range Anti Aircraft	300	unk	14	30	30	30
Short Range Anti Aircraft	680	unk	2	12	12	12
MLRS	237	200	55	41	41	41
Combat Aircraft	553	423	205	228	228	226
<i>France</i>						
Main Battle Tanks	2001	614	254	222	222	222
Light Tanks	171	28	28	0	0	0
Infantry Fighting Vehicles	1141	701	786	872	850	951
Armoured Vehicles	5101	5484	5055	3828	3988	4072
Howitzers	786	375	120	89	88	88
Long Range Anti Aircraft	180	98	unk	40	40	40
Medium Range Anti Aircraft	69	26	0	0	0	0
Short Range Anti Aircraft	150	331	unk	24	24	24
MLRS	30	61	26	13	13	13
Combat Aircraft	215	222	238	227	227	228
<i>United Kingdom</i>						
Main Battle Tanks	1276	543	227	227	227	227
Light Tanks	312	464	200	176	176	176
Infantry Fighting Vehicles	605	575	350	388	388	388
Armoured Vehicles	5941	4054	2763	2586	2590	2579
Howitzers	723	344	233	215	215	215
Long Range Anti Aircraft	0	0	0	0	0	0
Medium Range Anti Aircraft	0	0	0	0	0	0
Short Range Anti Aircraft	200	192	74	74	74	74
MLRS	47	63	35	35	35	35
Combat Aircraft	274	510	285	162	162	167
<i>Poland</i>						
Main Battle Tanks	2880	947	893	606	808	797
Infantry Fighting Vehicles	1471	1281	1867	1611	1611	1611
Armoured Vehicles	1437	468	436	860	860	864
Howitzers	2222	1014	401	419	394	410
Long Range Anti Aircraft		125	1	1	1	1
Medium Range Anti Aircraft	410	80	0	20	20	20
Short Range Anti Aircraft		316	81	64	98	81
MLRS	262	249	180	197	179	179
Combat Aircraft	332	242	106	95	94	94

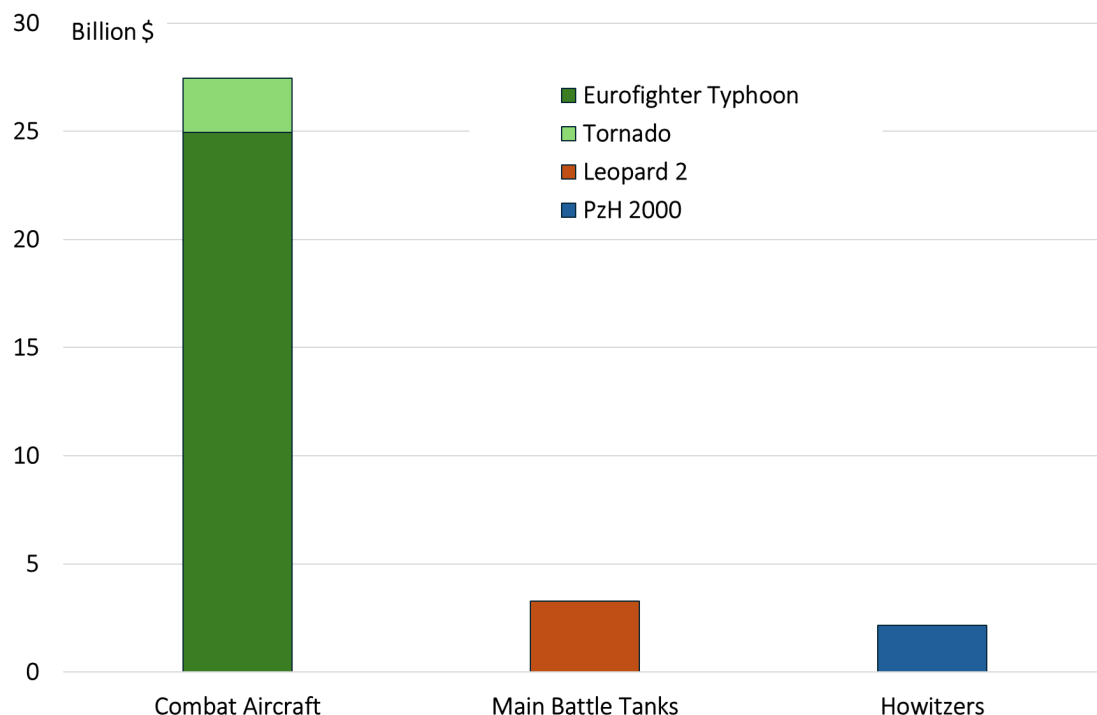
Note: This table shows the absolute number of weapons in selected categories. It does not distinguish between the quality of the weapons.

Source: IISS (1992, 2004, 2014, 2020, 2021, 2022).

¹⁹ See the Federal Ministry of Defence (Germany). “European Sky Shield – die Initiative im Überblick“, <https://www.bmvg.de/de/aktuelles/european-sky-shield-die-initiative-im-ueberblick-5511066>

A weapon category that NATO especially emphasises is combat aircraft. Without military analysis, it is difficult to compare the military value of different weapon systems. As economists we can, however, compare the monetary value of different types of weapon systems. First, Figure 3.1 compares the value of the stocks using the current prices of military equipment measured in US Dollars. The figure shows that, at least in monetary terms, Germany has greatly emphasised combat aircraft in its military stock. In response to the February 2022 attack, Germany has continued to invest in combat aircraft, as it ordered 35 F35 fighter jets. Second, Figure A3.2 in Annex A3 compares the value of the stocks for all four countries using a price indicator from SIPRI. This indicator takes into account and attempts to standardise different production costs that different countries have for the main weapon systems. Figure A3.2 shows that the four key NATO countries that we consider in Europe all have vastly more valuable stocks of combat aircraft than of all the other main categories of weapon systems.

Figure 3.1:
German military capabilities in three categories, value in US dollars (2021)



Note: The figure shows the aggregate US dollar value of German military stock in 2021 for fighter aircraft, main battle tanks, and howitzers. For the sake of comparability, we do not distinguish between the age and quality of the weapon when calculating the dollar value. Thus, all Leopard 2 tanks have the price of a new Leopard 2A7 tank. The prices are based on the most recent sources of public announcements published on <https://bmvg.de/>. The only exception is the Tornado fighter jet, whose price comes from the SIPRI Trade Register and shows the price for the procurement of a used Tornado fighter jet. All prices are deflated to \$2022 using the BEA (US Bureau of Economic Analysis) GDP deflator for National Defence (BEA's Table 1.1.4. Price Indexes for Gross Domestic Product). For a discussion of the reliability of estimated prices, see Annex 3, especially Figure A3.1.

Source: Data on stocks comes from IISS (2021). Price data comes from SIPRI and various public sources.

We cannot assess the current operational state of military equipment, but acknowledge that **combat power sustainment is a significant challenge for Germany and other countries.** The maintenance of existing military equipment is an issue for any military. In Germany, this topic has repeatedly arisen as a serious constraint of the armed forces, as substantial gaps in sustainment lead to the inoperability of large parts of the armed forces equipment. We have not analysed the topic but do want to highlight that actual numbers of key weapon systems in Europe may be even lower than what we present. On the other hand, the German military industry (e.g. Rheinmetall) holds an unknown amount of decommissioned weapons stock, which may not be currently operational but could be retrofitted in case of future need.

4 INTRODUCING THE **KIEL MILITARY PROCUREMENT TRACKER**

Given the dramatic increase in Russian military capabilities over the past few years, the sharp reduction in European military stocks over the past few decades, and the grim reality that a long war of attrition has once again returned to Europe, it is important to ascertain whether European countries are responding appropriately to the situation and sufficiently rebuilding their forces. To aid in this task, the *Kiel Military Procurement Tracker* systematically and comparatively tracks the military procurement of European countries. By taking official announcements and press releases from a European country's ministry of defence website, we can record military orders. In a first step, we have built the database for Germany. See Annex A4 for specific websites we use.

Our database tracks information on the item ordered, the company from which it is ordered, the number of units ordered, the earliest expected delivery date, the latest expected delivery date, the monetary amount of the order, the budgetary vehicle that provides for the funding, and whether the order is part of a framework agreement. It also records the country in which the headquarters of the company responsible for fulfilling the order is located as well as the physical production or manufacturing country of the order in cases where the information is available.

We classify orders into 15 general item types: tanks, armoured vehicles, artillery, ammunition, air defence systems, missiles (further differentiated into land, naval, and air variants), drones, infantry, mines, helicopters, aircraft, naval, modernisation (refers to the improvement of the armed forces as a whole), and other. Each general item type has a subcategory for research and development in that category.

The database only includes items mentioned as military orders or expenses by official government news and press release pages. Orders for which an official source has not been found are excluded completely. Information from government sources forms the basis of the database and carries the most weight and authority in case of discrepancies with other sources. In cases where the government source omits important information pertaining to an order, unofficial news sources such as company webpages that specifically refer to the order and contain missing details may be used to supplement the official source and fill out the database as much as possible.

The first country whose procurement we track is Germany, due to its central role in Europe and strong industrial base. According to German law, the Bundestag Budget Committee must approve any military procurement over €25 million. In all but a few cases, the date we associate with an order is the date the Budget Committee approved the order. For remaining cases, the date we associate with an order is the date of the official government announcement.

The second country whose procurement we track is France. This part of the database is still under construction and lacks the level of sophistication of the German case. The French order information we have so far been able to find only covers a part of the overall budgetary allocation, so we chose not to present results for France in this report.

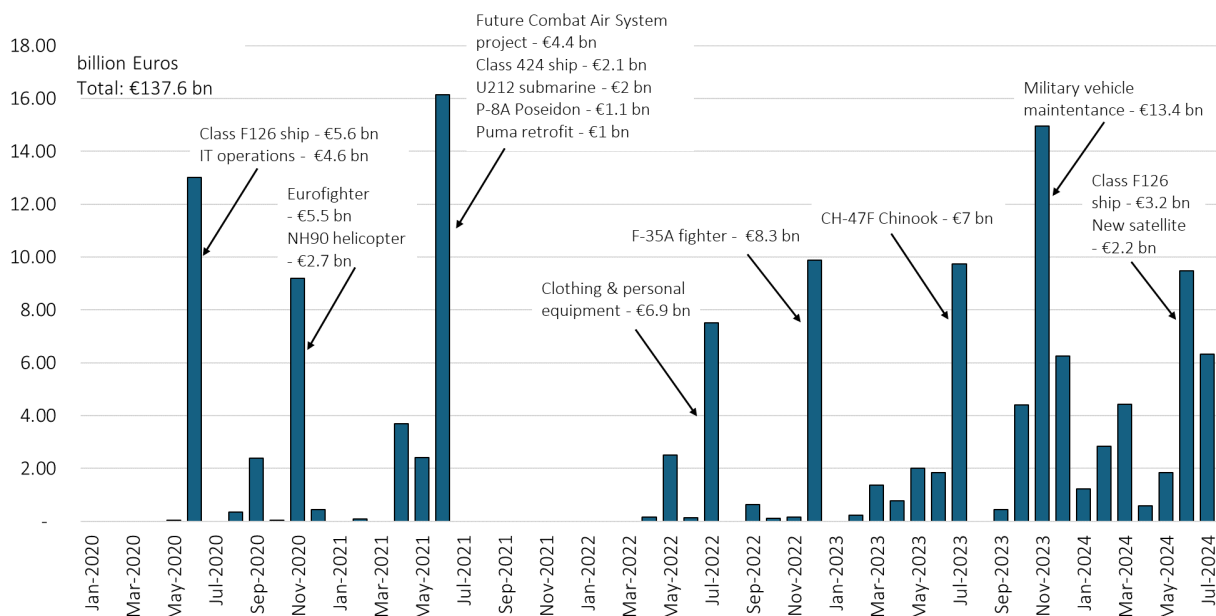
We intend to further develop and improve the *Kiel Military Procurement Tracker* so that it continues to serve as a useful tool to anyone seeking to understand military procurement in this crucial moment for European rearmament.

5 MILITARY PROCUREMENT IN GERMANY

From January 2020 to July 2024, the *Kiel Military Procurement Tracker* identifies 187 orders covering 221 items worth a total of €137.6 billion for Germany. **Figure 5.1 shows the pattern of these orders. Four major results stand out. First**, it documents that from July 2021 (ahead of the federal election in September and the appointment of the new government in December 2021) until April 2022, Germany placed no substantial order. **Second**, in the first one and a half years after the war started, no notable increase in procurement activity is visible. On the contrary, orders appear to have dropped. Between January 2020 and June (included) 2021, Germany ordered €47.8 billion, whereas between January 2022 and June (included) 2023, Germany ordered €27.3 billion. The war therefore does not appear to have initiated a rapid increase in items ordered in its first year. **Third**, as of summer 2023, a substantial increase is visible and the frequency of orders rises. Between July 2023 and July (included) 2024, Germany made military purchases worth €62.5 billion. If the average monthly spending of this period were to continue until the end of 2024, Germany would have ordered €93.8 billion in the one and a half years since July 2023 to December 2024. In the whole period since the war started, i.e., between March 2022 and July (included) 2024, we identify 122 orders covering 148 items worth €89.9 billion. **Fourth**, in some months there are substantial spikes in orders, which are usually associated with purchases of expensive equipment such as ships or aircraft. Some of these big orders were undertaken by the previous government. A major expenditure for military vehicle maintenance also stands out in November 2023.

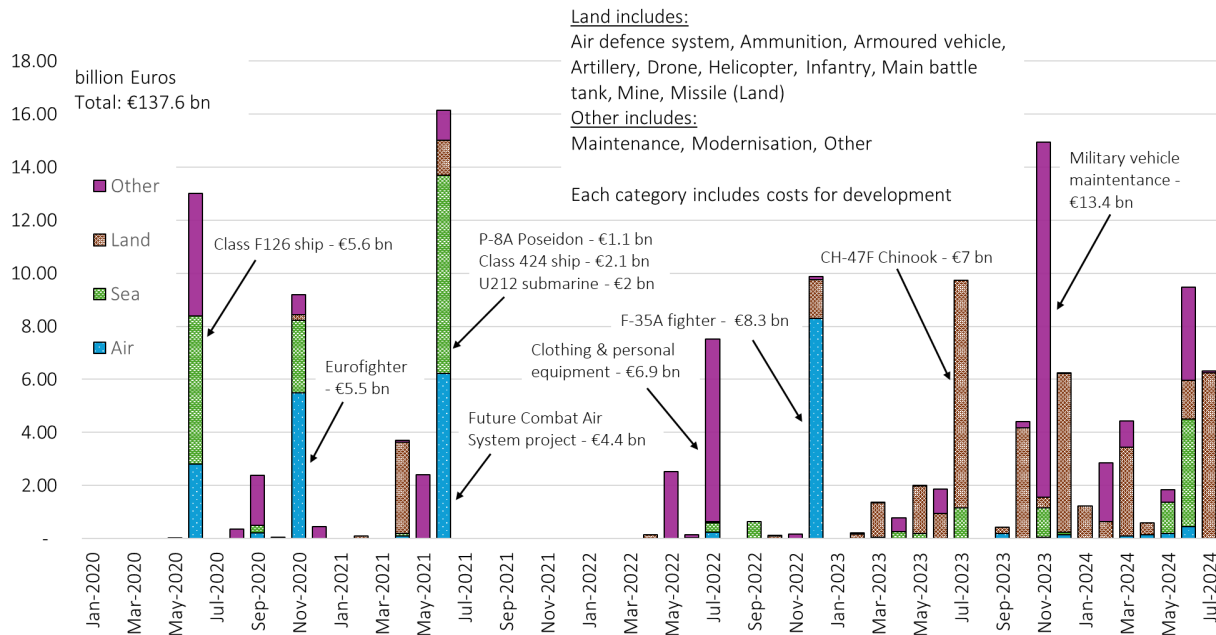
Breaking down orders by weapon category shows a mix between land forces and air force orders. Figure 5.2 breaks down the orders across weapon categories. Orders for land forces appear to have gained in importance but remain relatively small.

Figure 5.1:
Germany total military orders, January 2020–July 2024 (billion Euros)



Source: Wolff, Kharitonov, Bushnell (2024).

Figure 5.2:
Germany total military orders by weapon category, January 2020–July 2024 (billion Euros)



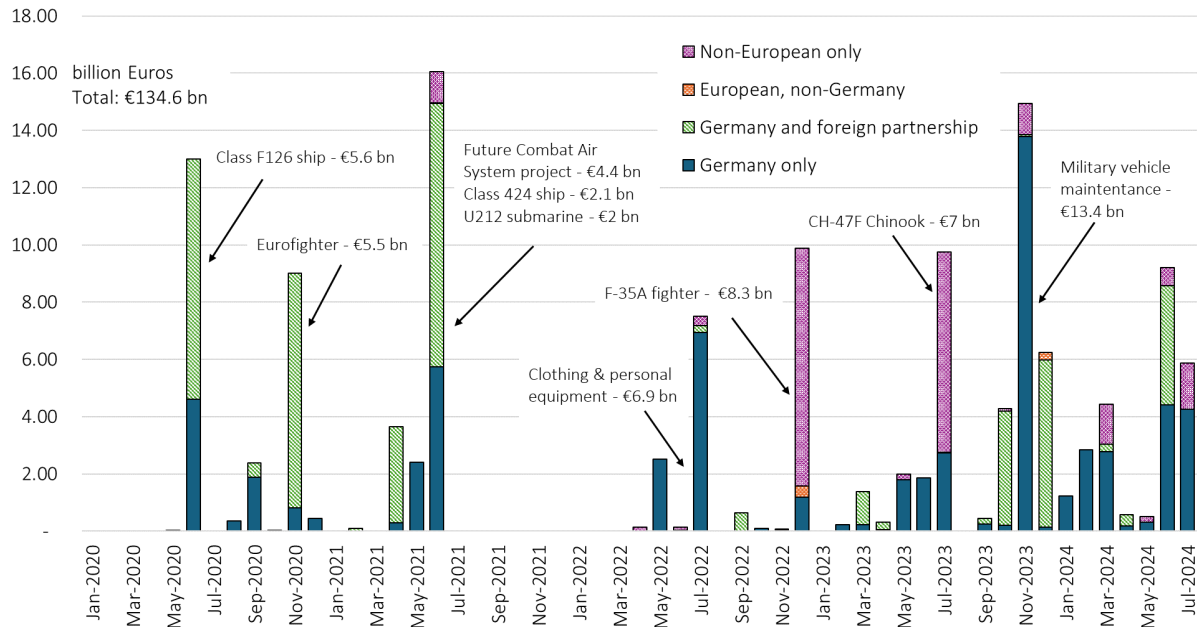
Source: Wolff, Kharitonov, Bushnell (2024).

Only a relatively small part of Germany's equipment spending is from foreign producers, without any German involvement in the production. Figures 5.3 and 5.3a provide a breakdown of the geographical regions of companies from which Germany has ordered weapons in the period analysed. We observe that while some high-profile orders such as the F35 fighter jets come from a US producer, almost half the orders come from purely German companies, and some 35% from a consortium involving foreign and German producers. The US by itself is the source of 16% of the orders. What is particularly noteworthy is the very low share of orders from other EU countries (1%). Finally, the orders from the US have become more substantial in the last two years. In 2020 and 2021, they were extremely limited.

Land war is back in Europe and Germany's investment in land capabilities picked up only slowly. Figure 5.4 shows orders for land forces equipment. It is visible that major orders only started in the second half of 2023. Disregarding large purchases such as the Chinook helicopters and the Patriot anti-aircraft missile systems, we see that orders are still quite small, suggesting that the build-up in land forces capabilities is slow at best.

Germany has substantially shifted its procurement priorities towards land forces in the period we analyse. Figure 5.5 shows how procurement for air/sea/land forces has shifted since 2022. We can observe a clear reorientation towards strengthening land forces. Nearly half of all German military purchases since 2022 have been for land forces. The substantial rise in 'Other' category in 2022–2024 is composed of a €13.4 billion military vehicle maintenance contract for 10 years and an increase in general modernisation costs (€10.2 billion to €15.8 billion), mostly attributed to clothing and personal equipment purchases. On the whole, air and sea forces have been substantially de-emphasised compared to land forces. What we cannot detect, however, is whether there has been a strong increase in spending on modern warfare. In particular, we cannot observe in the data substantial spending on drone warfare.

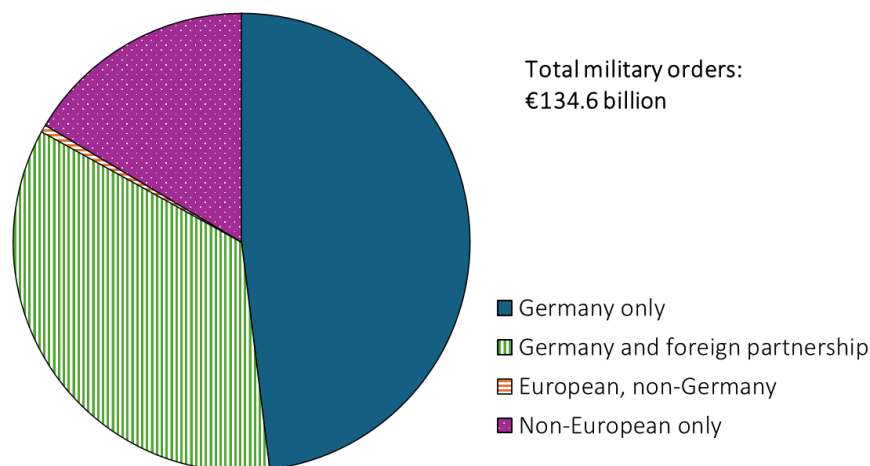
Figure 5.3:
Germany total military orders by country of origin of the company which received the order, January 2020–July 2024 (billion Euros)



Note: This figure refers to the country where the headquarters of the company that received the order is located. As such, the location of actual item production and manufacturing may differ. "Germany and foreign partnership" refers to cases where a German and non-German company jointly receive an order, i.e., they work together on developing and producing an item. We cannot confirm development country for around €3.1 billion worth of total orders.

Source: Wolff, Kharitonov, Bushnell (2024).

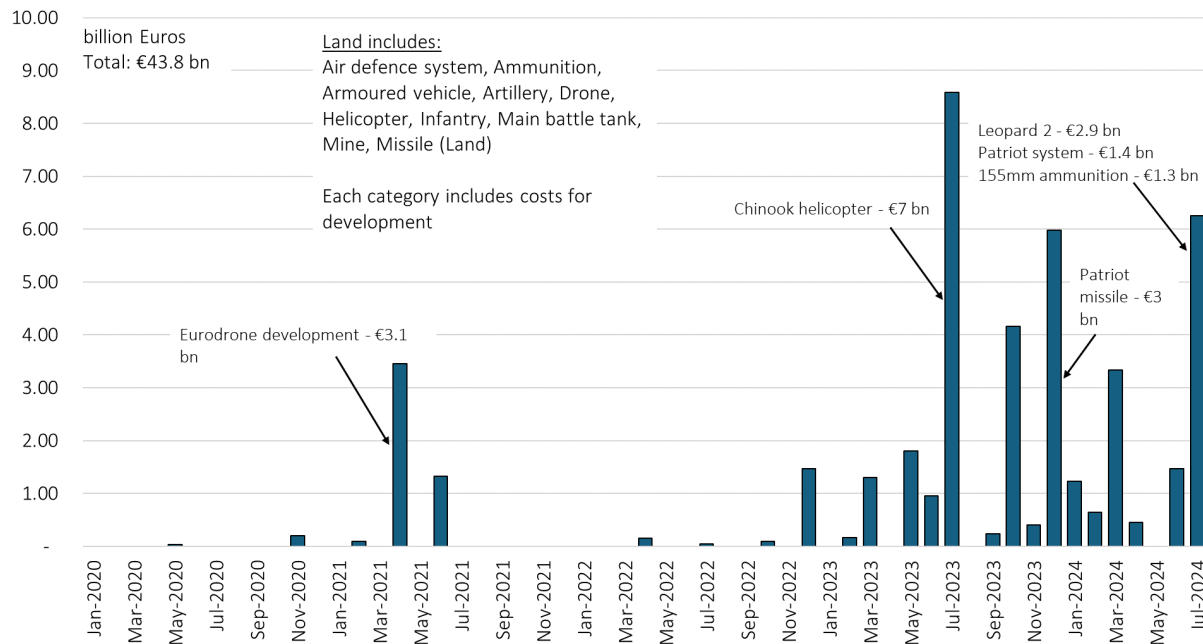
Figure 5.3a:
Germany share of total military orders by country of origin of the company which received the order, January 2020–July 2024 (billion Euros)



Note: This figure refers to the country where the headquarters of the company that received the order is located. As such, the location of actual item production and manufacturing may differ. "Germany and foreign partnership" refers to cases where a German and non-German company jointly receive an order, i.e., they work together on developing and producing an item. We cannot confirm development country for around €3.1 billion worth of total orders.

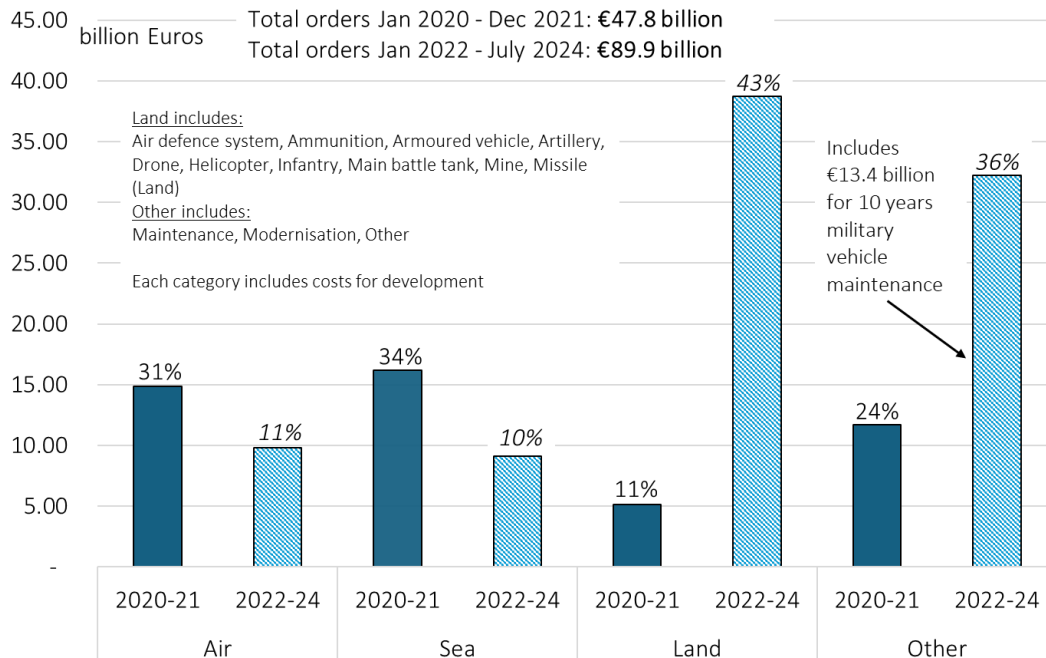
Source: Wolff, Kharitonov, Bushnell (2024).

Figure 5.4:
Germany military orders for land forces by month, January 2020–July 2024 (billion Euros)



Source: Wolff, Kharitonov, Bushnell (2024).

Figure 5.5:
Germany shift in procurement priorities since the start of the Russia Ukraine war

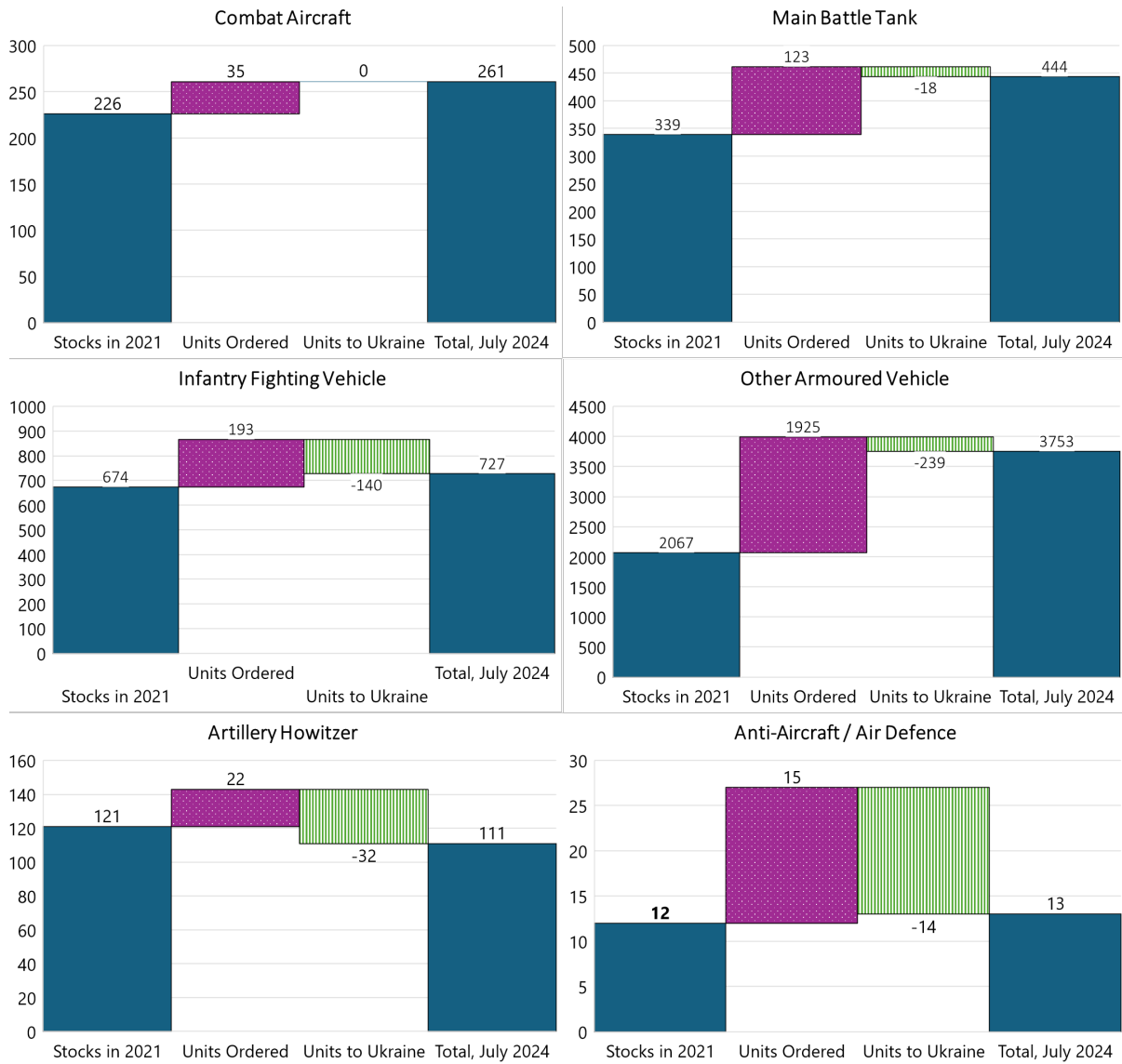


Note: This figure compares the monetary amount Germany ordered in military procurements in each category (Air, Sea, Land, Other) in the periods from January 2020 to December 2021 and from January 2022 to July 2024. It also shows the percentage of total orders for each category for each time period.

Source: Wolff, Kharitonov, Bushnell (2024).

A significant portion of German military procurement has only gone towards replacing weapon commitments to Ukraine and, accordingly, the increase in German capacities is less than the procurement data suggest. Figure 5.6 documents the estimated change in 2021 stocks as a result of new equipment orders that are expected to be delivered as well as weapon commitments to Ukraine. It should be noted that a significant quantity of ordered equipment has not yet been delivered. Likewise, a significant proportion of the weapons Germany committed to Ukraine, taken from the Ukraine Support Tracker, has also not yet been delivered. The key result from this chart is that the ordering activity of the last two and a half years has barely changed the stocks available to the German army. In most instances, they have merely been enough to replace the reduction in stocks due to commitments to Ukraine. While for “other armoured vehicles”, a significant increase in stocks is visible, for howitzers German capacities have actually been reduced by commitments to Ukraine.

Figure 5.6:
Impact of orders of new weapons and commitments to Ukraine on the stock of six major weapon categories in Germany



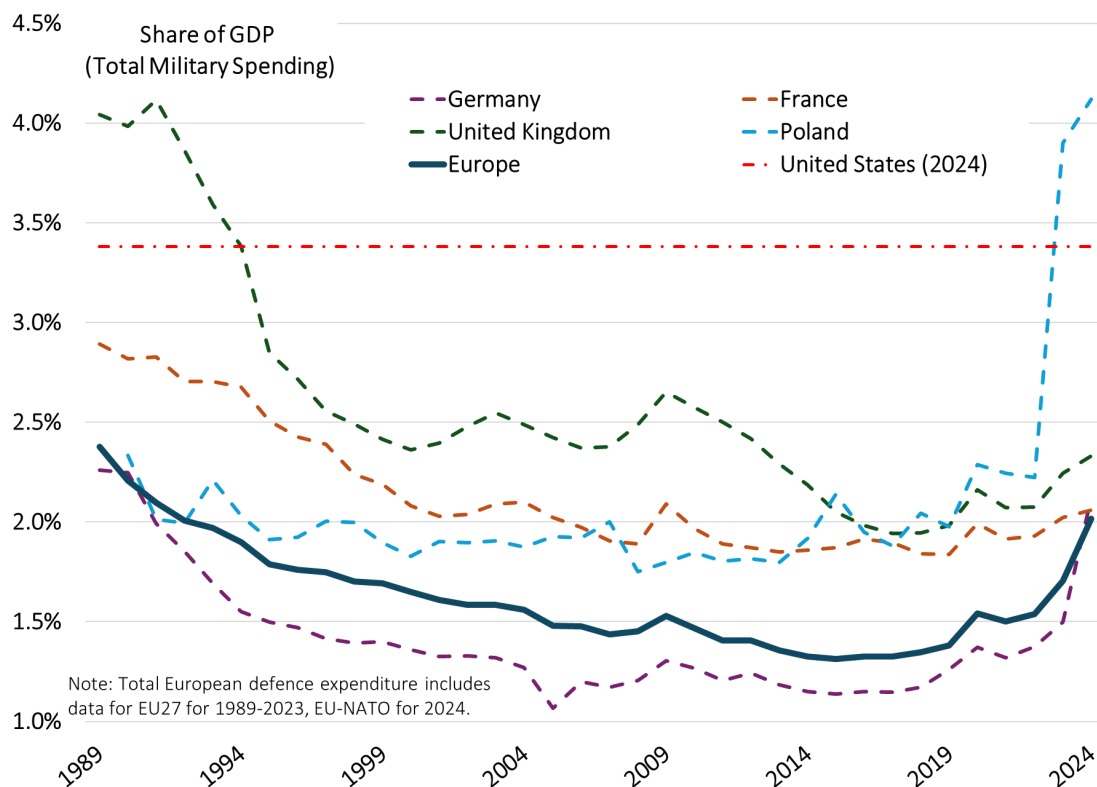
Note: This figure shows the comparison between German key weapon stocks in 2021; units ordered (February 2022 to July 2024); units promised to Ukraine (February 2022 to June 2024); and the remaining number available (or to be delivered) to the Bundeswehr as of July 2024. The key weapon categories are: (1) combat aircraft; (2) main battle tanks (MBTs); (3) infantry fighting vehicles (IFVs) (orders include both new vehicles and retrofits of existing vehicles); (4) other armoured vehicles (stocks and orders exclude infantry fighting vehicles and light tanks); (5) artillery howitzers; and (6) anti-aircraft, air defence weapons (stocks include long-range anti-aircraft systems, and orders include long- and medium-range systems). In this figure, we assume that providing units to Ukraine is the only outflow of German stocks.

Source: IISS (2022); Trebesch et al. (2024); Wolff, Kharitonov, Bushnell (2024).

6 GERMANY'S MILITARY PROCUREMENT AND THE BUDGET

Germany's defence spending has been small compared to other European countries. Figure 6.1 documents the development of European defence spending budgets according to their NATO definition since the end of the Cold War. The fall of Germany's defence budget was pronounced and since the early 1990s, Germany has consistently spent significantly less than the EU average. The increase in Germany's spending in 2023 was also not particularly large compared to Poland in particular. Poland's defence budget increased massively in the wake of the Russian aggression in Eastern Europe. Dorn (2024) and Dorn et al. (2024) review European defence spending in detail.

Figure 6.1:
Defence spending across selected EU countries in percent of GDP

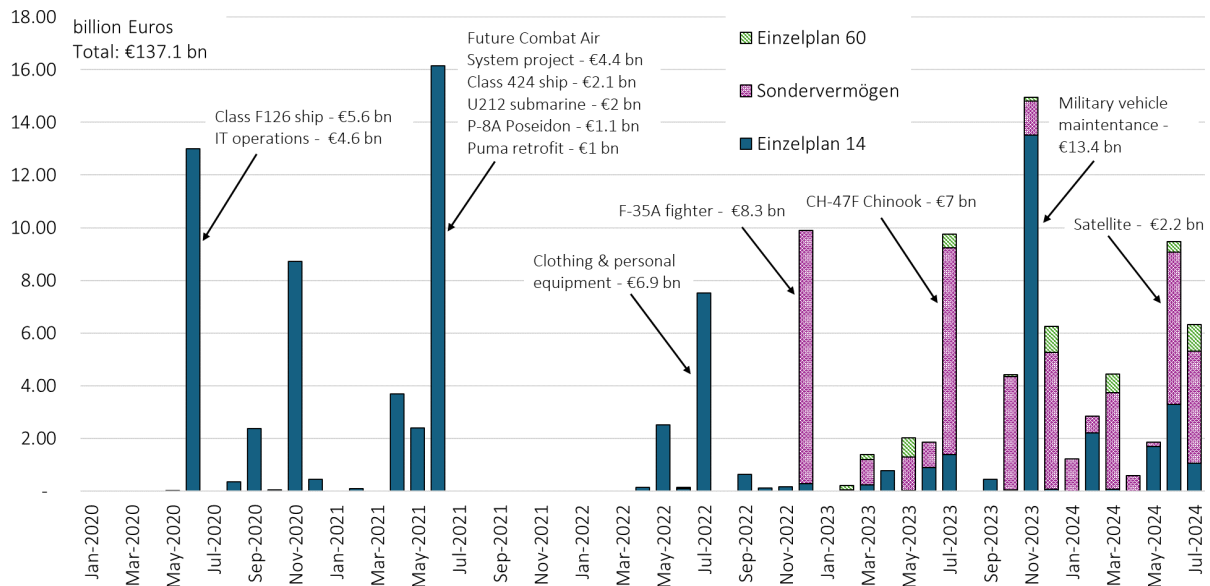


Source: Own calculations, based on NATO, SIPRI and World Bank data. Defence expenditures are nominal SIPRI military expenditure data normalized by nominal World Bank GDP data for 1989 to 2023. Data for 2024 are NATO estimates. European average expenditures for 1989–2023 represent the EU27, while NATO estimates we used for 2024 include only EU members that are also NATO members, thus excluding Austria, Cyprus, Ireland, and Malta.

Germany's small regular defence budget is supplemented by a special debt vehicle and a budget line for the support of third countries. The current regular defence budget, Einzelplan 14, is only €52 billion, i.e., around 1.2% of GDP. It is, however, supplemented by the Sondervermögen, a debt-funded fund of €100 billion that is mostly used for purchasing new equipment. The special fund was created in 2022 through an amendment to the German constitution to allow a special debt vehicle outside of the German constitutional debt brake. Moreover, spending for purchases that benefit third countries, in particular Ukraine, comes from a third budget line,

Einzelplan 60. Figure 6.2 separates the purchases into the three budget vehicles and shows that the Sondervermögen has become the dominant source of funding for military procurement.

Figure 6.2:
Germany total military orders by budgetary fund, January 2020–July 2024 (billion Euros)



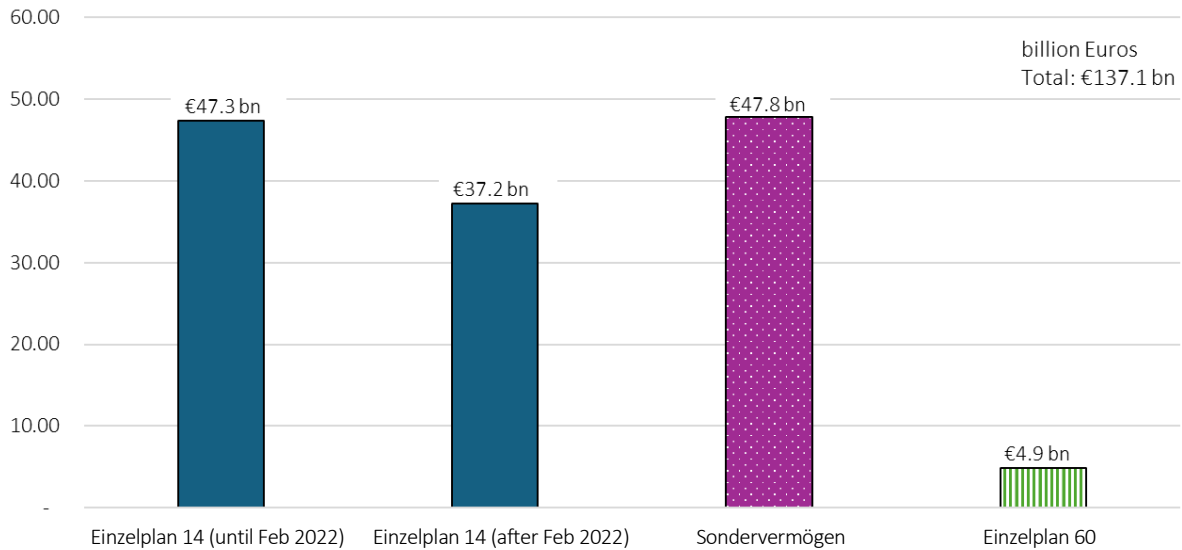
Note: Around €16.1 billion worth of orders is attributed to both the Sondervermögen and regular defence budget, Einzelplan 14. In the absence of further details, we assume that these orders are funded by the Sondervermögen until the fund is exhausted in 2027 and then any additional costs will be paid by the regular defence budget. In these cases, we attribute the value of the whole order to the Sondervermögen. Around €0.6 billion worth of orders is attributed to the Sondervermögen and Einzelplan 60. We count these orders as Einzelplan 60. Furthermore, in cases where the funding vehicle is not specified, we attribute the value of the order to the regular defence budget, Einzelplan 14.

Source: Wolff, Kharitonov, Bushnell (2024).

Equipment spending from the regular defence budget has decreased rather than increased since February 2022. Spending from the regular defence budget for military purchases appears to have fallen (Figure 6.3). When looking at spending for land forces more specifically, almost no funds from Einzelplan 14 are currently used for purchases and all purchases have moved to the Sondervermögen (see Figures A6.1 and A6.2 in Annex A6).

The budgetary shift towards the Sondervermögen is also visible in the parliamentary financial commitments towards future budgetary years (the so-called commitment appropriations, or “Verpflichtungsermächtigungen”). Figure 6.4 documents Verpflichtungsermächtigungen, i.e., Bundestag authorisations that allow the government to enter into financial commitments that will only be paid in later budgetary years. The first message of the figure is a positive one: future budgetary resources have been committed, which allows the government to increase its procurement using promises of future payments. However, the figure also shows that, based on the 2024 appropriations, almost all of the future budgetary increase for the next three years comes from the Sondervermögen (see Panel A). The comparatively low appropriations for the regular defence budget in these three years imply that future budgetary planning without the Sondervermögen will most likely face substantial adjustment challenges. In particular, Panel B

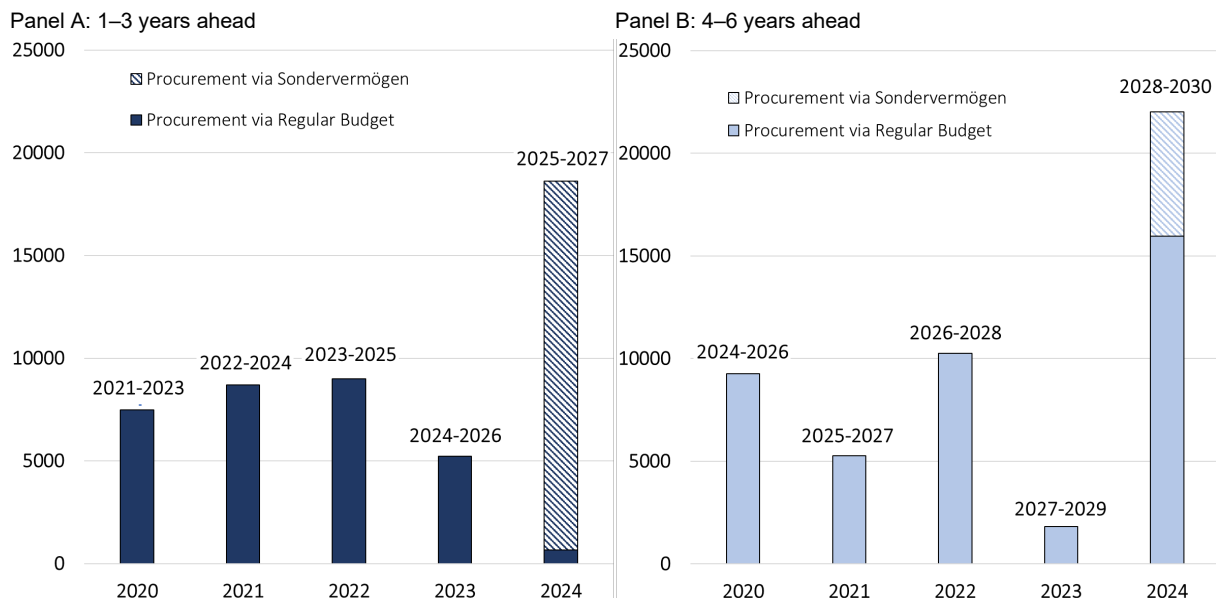
Figure 6.3:
Germany total military orders by budgetary fund overview, January 2020–July 2024 (billion Euros)



Note: Around €16.1 billion worth of orders is attributed to both the Sondervermögen and regular defence budget, Einzelplan 14. In the absence of further details, we assume that these orders are funded by the Sondervermögen until the fund is exhausted in 2027 and then any additional costs will be paid by the regular defence budget. In these cases, we attribute the value of the whole order to the Sondervermögen. Around €0.6 billion worth of orders is attributed to the Sondervermögen and Einzelplan 60. We count these orders as Einzelplan 60. Furthermore, in cases where the funding vehicle is not specified, we attribute the value of the order to the regular defence budget, Einzelplan 14.

Source: Wolff, Kharitonov, Bushnell (2024).

Figure 6.4:
Bundeswehr Procurement Budget, Commitment Appropriations in Section 14 (Einzelplan 14) and Special Fund (Sondervermögen) (million Euros)



Note: This figure shows total funds committed for spending in future fiscal years in budget years 2020–2024. Panel A shows funds committed for 1–3 years ahead and Panel B shows funds committed for 4–6 years ahead. The bottom of the chart shows the budget year in which the funds were committed, and the top of the bar shows the period for which those funds were committed.

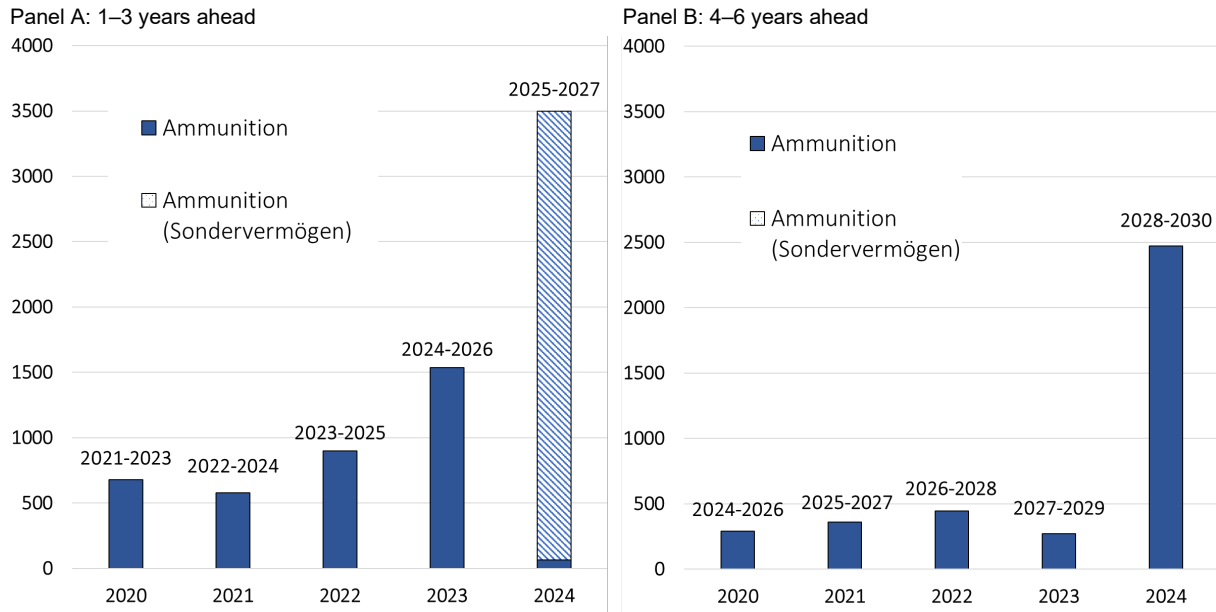
Source: Bundeshaushaltsplan 2020–2024.

shows that the increase in budgetary commitment for the years 2028–2030 includes substantial funds from the regular defence budget. Yet there is no indication that the regular defence budget is being sufficiently increased in the coming years to create the budgetary space for such commitments. It would seem that, rather than gradually building up the regular defence budget over the next several years, the German Bundestag expects that in 2028 the Einzelplan 14 will dramatically increase and be high enough to sustain greater levels of appropriated commitments than ever before – a risky political bet. Finally, it is important to note how commitment appropriations experienced quite a drop in 2023, suggesting an ambiguous political understanding of future budget needs. Mölling and Schütz (2023) also point to inadequate budgetary commitments in that year.

Ammunition procurement has received particular attention due to the high demand of it in Ukraine. Last year, Germany's budgetary messages concerning future demand were ambiguous. Figure 6.5 shows that commitment appropriations for ammunition purchases have increased particularly in budget year 2024, where a high level of funding is ensured until 2030. In budget year 2023, however, the commitment appropriations increased for the short-term (1–3 years ahead) but then fell strongly for the medium-term (4–6 year ahead). Such uncertainty surrounding future German demand has certainly not been a helpful signal to industry to build-up capacities for production. A similar pattern is visible for **combat vehicles. In the 2023 budget, commitments for future purchases appear to have even declined compared to previous years. It is only in the 2024 budget that Germany signalled a clear commitment to fund future combat vehicle production** (see Figure A6.3 in Annex A6).

Defence companies face substantial uncertainty about Germany's budgetary commitments to future weapons purchases, which likely means that investment in production capacities is lower than it could be. The medium-term financial planning of the German government does not provide the assurance to weapon producers that future demand will be there. In particular, the government's current budgetary planning foresees that the regular defence budget, Einzelplan 14, will remain virtually unchanged at around €52 billion until 2027. In 2025, the increase of Einzelplan 14 barely compensates for inflation. In 2028, the medium-term financial plan foresees a sudden increase of Einzelplan 14 to €80 billion, or close to 2% of German GDP. A budget shift of that magnitude cannot happen from one year to the next without a major political decision. It is more than uncertain that political consensus can be reached for such a decision. Until 2027, the funding gap to the NATO 2% goal is plugged with the Sondervermögen. Given the uncertainty of future debt issuance under Germany's strict debt brake, no weapon producer can be certain about demand beyond 2027. Consequently, investment into German military capacities remains subdued.

Figure 6.5:
Bundeswehr Ammunition Procurement Budget, Commitment Appropriations in Section 14 (Einzelplan 14) and Special Fund (Sondervermögen) (million Euros)



Note: This figure shows total funds committed for spending in future fiscal years in budget years 2020–2024. Panel A shows funds committed for 1–3 years ahead and Panel B shows funds committed for 4–6 years ahead. The bottom of the chart shows the budget year in which the funds were committed, and the top of the bar shows the period for which those funds were committed.

Source: Bundeshaushaltsplan 2020–2024.

7 UNCOVERING THE GAP BETWEEN PROCUREMENT AND PRODUCTION

European production capacity at the start of the Russia Ukraine war in 2022 was limited. Years of minimal investments into military equipment combined with relatively strict export controls meant that over the past few decades the European defence industry has shrunk to a relatively small industry with an annual turnover estimated between €70 and 120 billion. According to the industry association ASD, in 2021 aeronautics comprised 41% of the combined defence and aeronautics market, land forces comprised 35%, and naval 23%.²⁰

Limited capacity has meant that domestic production could not keep up with the surge in demand and, subsequently, imports have increased. Wolff (2024) and Mejino-Lopez and Wolff (2024) analyse the role of imported equipment in European defence. They show that although imports have increased since the start of the war in 2022, the majority of equipment purchases are still made from domestic producers. Meanwhile, trans-European orders are limited.

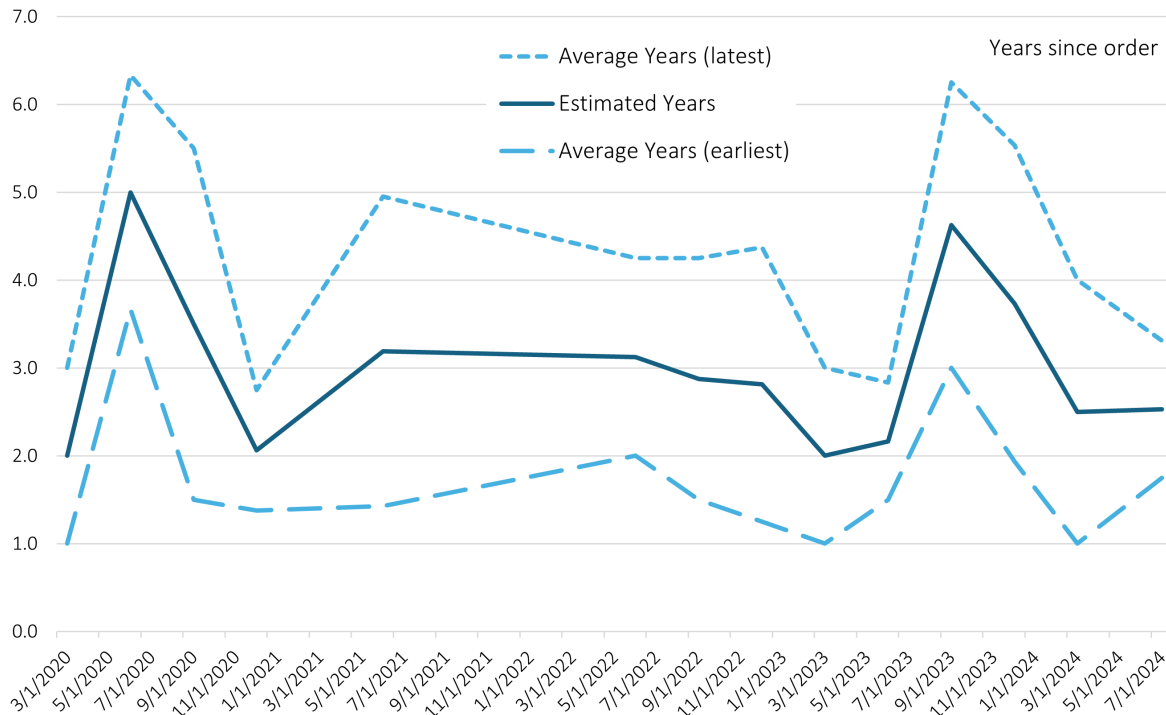
Germany's new orders do not translate into immediate deliveries. The *Kiel Military Procurement Tracker* records the earliest and latest expected delivery dates. However, out of 221 observations, both of these dates are only given for 106 orders. We assume that for the observations without specified dates expected delivery dates cannot yet be estimated and are probably not yet set in contracts. This assumption suggests that these items may arrive later than those for which expected delivery dates are set. We consider that Figure 7.1 therefore gives an optimistic picture of expected delivery dates over time. The figure shows that expected delivery dates have neither improved nor deteriorated during the last two years. Deliveries continue to come with delays of 2–4 years, which of course means that anything not yet ordered will not arrive before 2026 or 2028 at the earliest. For a critical number of years, German military planners will therefore have to cope with having more or less current levels of equipment stocks plus the small changes we have documented. In these same critical years, the capacities of Putin's Russia will significantly strengthen and Western leadership may possibly weaken.

However, the share of orders without a final delivery date has been rising, so Figure 7.1 might be overly optimistic. Since we capture both the earliest and latest delivery dates for only half of the orders, we show in Figure 7.2 the proportion of ordered items without a latest expected delivery date. Since 2023, that proportion has been rising, suggesting that as orders have been rising, companies have faced difficulties committing to firm final delivery dates. This trend suggests that production bottlenecks may have become more of an issue.

European production has been increasing in the last two and a half years but remains below what is needed. Output data for military equipment such as tanks or air defence systems are not readily available, but there are some estimates for ammunition production. A European Commission press release states that the annual production capacity in Europe for 155mm artillery shells will reach 1 million in 2024. The Commission anticipates that by the end of 2025

²⁰ The EU's EDIS document speaks of around €70 billion while the ASD annual report gives the number of €118 billion in 2021. The ASD report also underlines that spending was so low that production capacities had become limited.

Figure 7.1:
Germany quarterly estimate of the number of years needed to deliver the ordered equipment where available, January 2020–July 2024



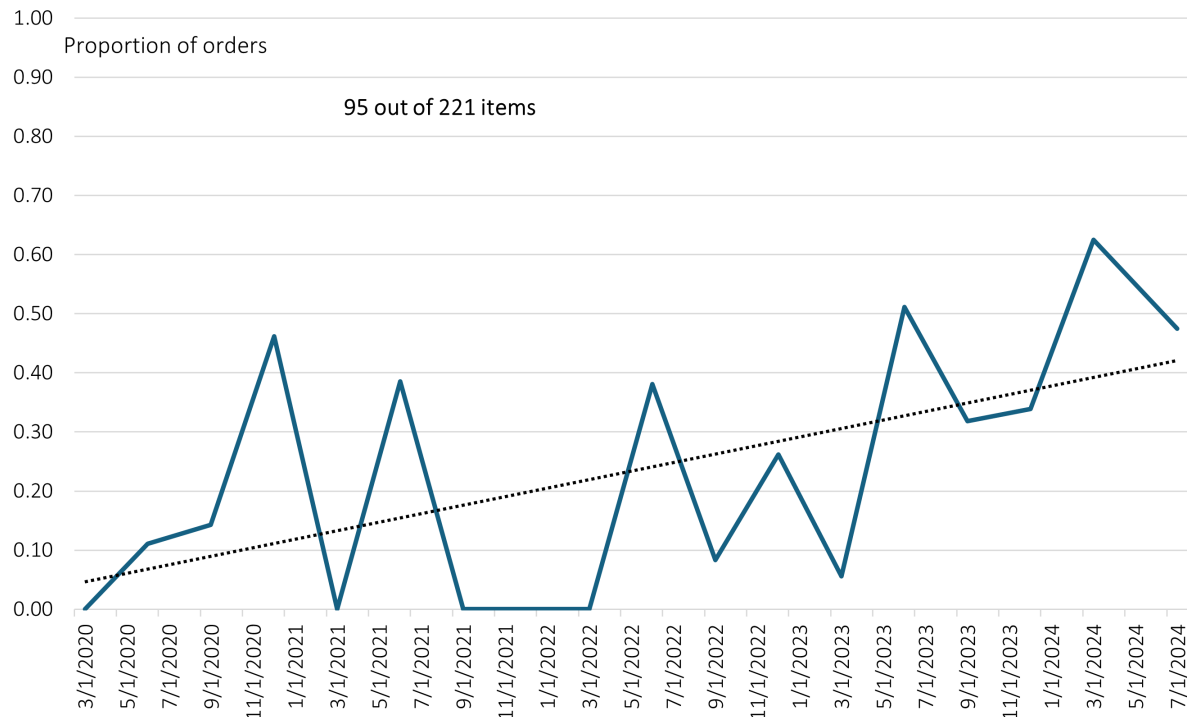
Note: Out of the 221 ordered items recorded for the years 2020–2024, 106 have both an earliest and latest expected delivery date. In cases where the order is not an item to be delivered per se (e.g. a maintenance contract), the “delivery date” refers to the expected date where the contractor’s obligation to provide a service to the Bundeswehr ends. This figure shows the estimated number of years it takes for an order to be fulfilled after it has been placed as a function of time. It shows the quarterly average years until an earliest expected delivery date and until a latest expected delivery date. We take a further average of these two quarterly values to estimate the average years it takes to fully deliver an item or fulfil an order. The average for the second quarter 2024 (April–June) includes orders for July 2024.

Source: Own calculations, based on Wolff, Kharitonov, Bushnell (2024).

the European production capacity for ammunition will increase to 2 million 155mm shells per year (European Commission, 2024). However, the Commission estimates are most likely too optimistic: European production numbers probably remain below these targets and European deliveries of artillery shells to Ukraine have also been well below the Commission announcements. Pugnet (2024) discusses how European shell deliveries have fallen short of EU promises. According to statements by industry leaders, such as Rheinmetall’s CEO Papperger, German shell production is will reach around 700 thousand by 2025 and is set to increase further.²¹ France, according to its defence ministry, increased its annual average 155mm shell deliveries for domestic Caesar howitzer use from 3000 in the period between 2017 and 2022 to 15,000

²¹ “From 2025, Rheinmetall plans to produce up to 700,000 artillery shells and 10,000 tons of gunpowder at its sites in Germany, Spain, South Africa, Australia and Hungary.” (Rheinmetall, June 2024), <https://www.rheinmetall.com/de/media/news-watch/news/2024/06/2024-06-20-rheinmetall-erhaelt-rekordauftrag-ueber-155mm-munition>

Figure 7.2:
Germany proportion of ordered items without a latest expected delivery date by quarter (January 2020–July 2024)



Note: This figure shows the proportion of a quarter's ordered items that do not have a latest expected delivery date (95 items). These items have either (a) no expected delivery date, or (b) only an earliest expected delivery date. Altogether Germany has ordered 221 items. The second quarter 2024 (April–June) includes orders for July 2024.

Source: Own calculations, based on Wolff, Kharitonov, Bushnell (2024).

between 2022 and 2025²². Its defence minister also said that France's shell delivery to Ukraine increased from 1000 per month in January 2023 to 3000 per month in January 2024.²³ These numbers show that Germany really is one of the crucial countries in Western Europe for ammunition production. Ruokonen (2024) provides detailed estimates of current ammunition production capacities, showing both the increase in capacities as well as the gap between current production and consumption rates.²⁴

²²See the Ministry of the Armed Forces (France), "Renforcement industriel : armement et munitions" (March 27, 2024). <https://www.defense.gouv.fr/actualites/renforcement-industriel-armement-munitions>

²³ See the Ministry of the Armed Forces (France), "Canon Caesar : Sébastien Lecornu salue la hausse de la production et la réduction des délais" (October 17, 2023). <https://www.defense.gouv.fr/actualites/canon-caesar-sebastien-lecornu-salue-hausse-production-reduction-delaix> and deliveries to Ukraine might be as high as 80 thousand per year (Camille Grand (@camille_grand), Twitter, March 28, 2024 https://x.com/camille_grand/status/1773339816609959973)

²⁴ see also <https://www.defenseone.com/business/2023/11/race-make-artillery-shells-us-eu-see-different-results/392288/>

When it comes to artillery and other systems, European production has increased but **remains low**. According to **France's** defence ministry, at the start of the Russia Ukraine war in February 2022, two Caesar cannons left the KNDS workshops each month. By October 2023, the company was able to assemble six of them per month and intended to increase this figure to **eight** by the start of 2024. In the same period, delivery times were also cut in half.²⁵ Meanwhile, **Germany** has ordered **22** KNDS Deutschland since 2022. However, it was only in June 2024²⁶ that the PzH 2000 was placed back into production at the company's facility in Kassel, Germany, with first deliveries scheduled in mid-2025. The 12 howitzers ordered in May 2023 are expected to be delivered in 2026, which suggests continued slow production rates. We estimate that production could possibly be around 5–6 PzH 2000 per year. The real constraint with PzH 2000 production will be the availability of hulls: since PzH 2000 and Leopard 2 tanks share the same hull, competition will be high. **Russia's** production of howitzers, as a reminder, currently stands at almost **40 per month**. Meanwhile, there has been no European order for MLRS yet despite proven effectiveness of HIMARS and Tornado systems in Ukraine, and production is correspondingly low. Production of Taurus cruise missiles in Germany has completely ceased.²⁷

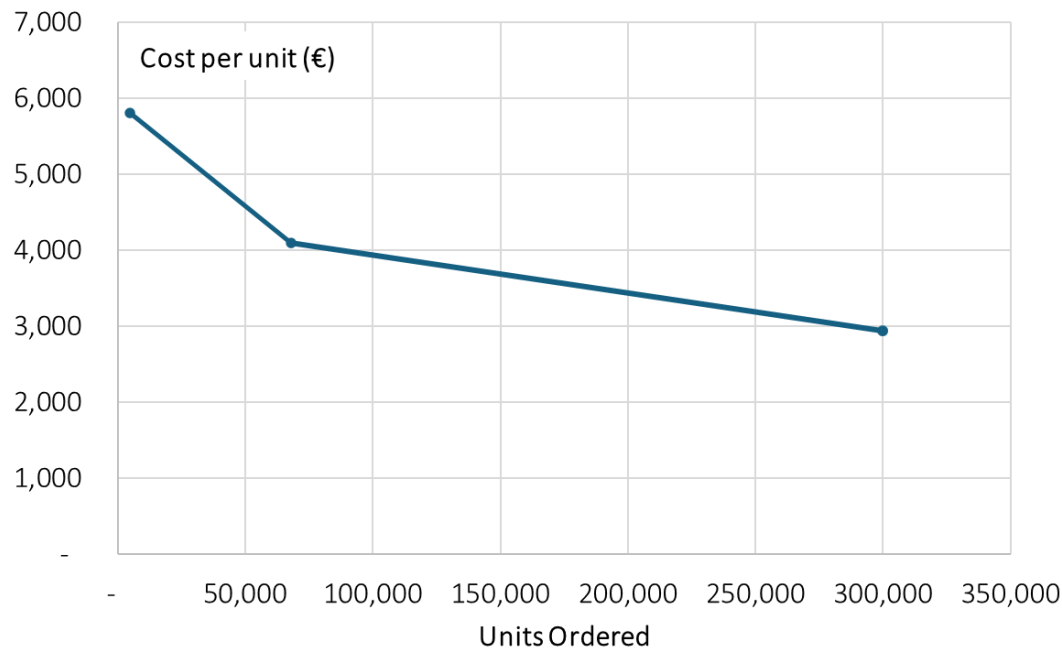
Finally, we want to emphasise that ordering low quantities invariably implies small economies of scale and relatively high unit costs. In the short term, increasing demand will drive up unit prices, as production capacities are currently limited. However, with a sustained increase in demand and higher quantities ordered, we would expect unit costs to fall as companies invest in industrial capacities. A first indication of this mechanism is found with artillery shells, where the increase in demand has been sustained and the political message has also become clear that more production will be needed. Figure 7.3 shows that unit costs are smaller when ordered quantities are higher, based on data from our *Kiel Military Procurement Tracker*. Moving from the current piece-meal approach to a more systematic strategy that increases quantities and provides long-term planning certainty is thus central to European rearmament.

²⁵ See the Ministry of the Armed Forces (France), "Canon Caesar : Sébastien Lecornu salue la hausse de la production et la réduction des délais" (October 17, 2023). <https://www.defense.gouv.fr/actualites/canon-caesar-sebastien-lecornu-salue-hausse-production-reduction-delaix>

²⁶ <https://www.shephardmedia.com/news/landwarfareintl/pzh-2000-self-propelled-howitzer-reenters-production-in-germany/>

²⁷ <https://defencesecurityasia.com/en/production-of-taurus-cruise-missiles-halted-after-no-new-orders-from-germany/>

Figure 7.3:
Germany 155mm howitzer ammunition unit costs as a function of quantity ordered



Note: This figure shows the relationship between number of units of 155mm howitzer ammunition ordered and the unit cost for that order. The Kiel Military Procurement Tracker records three orders of 155mm howitzer ammunition that include information on both number of units ordered and the total monetary amount of the order.

Source: Wolff, Kharitonov, Bushnell (2024).

8 CONCLUSIONS

This report has assessed the state of military equipment and procurement in selected European countries and in Germany in particular. Two and a half years into the Zeitenwende, our assessment is that German military capabilities have not been fundamentally increased to meet the challenge. We document this finding by using two benchmarks. **First**, we benchmark capacities against Russian military capacities and Russia's surging output. We show not only that Russian output has been increasing in the last two years but that Russia now has access to a new supply of equipment sufficient enough to build up three new armies (with a possible joint capacity of up to 20,000 combat troops and covering up to 150 km of frontline) that it can employ in the Ukrainian theatre as early as this autumn. Russian monthly production rates are now so high that they would be able to fill the entire German stock of military equipment in around half a year. **Second**, we benchmark procurement activities relative to the gap between current German capacities and those from 20 years ago. Our findings show that it will take decades if not centuries to build up similar capacities to 2004 at current procurement speeds. When taking into account commitments to Ukraine, we even document that procurement for some weapon systems is insufficient to replace commitments and existing deterrence capabilities are actually falling.

The state of affairs for German rearmament is thus dire – and all the more so if Europe cannot continue to take US support for Ukraine and for collective deterrence for granted. A report by the Commission on the National Defense Strategy argues that US military capacities are overstretched and the US is currently not able to fight a major global war (RAND, 2024). The results of the November 2024 US presidential election are relevant. A second Trump administration, with JD Vance as vice-president, would mean a certain decline in support for a large-scale military commitment in Europe. But even a Harris administration would find it difficult to manage global American commitments in a way that provides credible defence and deterrence in every theatre. More importantly and beyond politics, **Europe needs to be aware that the US is not an unlimited warehouse for weapons and ammunition.** A study by the Center for Strategic and International Studies (Cancian, 2023) shows that inventory replacement times in the US are quite high, which implies that deliveries outpace production. The situation is aggravated for some critical systems such as long-range artillery like HIMARS, hypersonic missiles, and air defence. These systems will be crucial in the Indo-Pacific and, especially, in any scenario involving Taiwan. Meanwhile, Russia has been able to make substantial advances in exactly these kinds of systems. Nonetheless, **Russia can be deterred, and a future conflict on NATO's eastern flank prevented, with credible European rearmament.**

We identify six priorities in need of rapid attention and change:

1 – Increasing speed: Germany has a speed problem when it comes to procurement. Meaningful increases in procurement activity did not begin until more than one year after the start of the full-scale invasion of Ukraine in February 2022. Since then, orders have remained rather small in size. For example, before July 2024 Germany only ordered 18 Leopard 2 tanks that were replacements for those committed to Ukraine. Finally, in July, two and a half years after

the start of the war, an additional 105 tanks were ordered. Yet even if these new 123 tanks are delivered quickly, Germany would still have only 440 main battle tanks – compared to 2400 back in 2004. For other weapon systems, the numbers look even less favourable. **It is urgent to accelerate the orders of key weapon systems.**

2 – Increasing the budget: Consistently small orders reflect a limited budget. The initial purpose of the Sondervermögen was to supplement an increasing regular defence budget that would reach the 2% NATO goal on its own. Instead, the regular budget, Einzelplan 14, has remained static, barely growing in line with inflation. Accordingly, the regular budget is currently too small to be used for significant purchases of equipment. Germany's medium-term budget planning foresees that Einzelplan 14 will suddenly grow from around €52 billion in 2027 (the level it will have been since 2024) to €80 billion in 2028. To revert to the example of tanks: a hypothetical order of 500 tanks in July 2024 would have shown a more serious commitment to ordering larger quantities than the actual 105. This order would have allowed Germany to reap economies of scale – but also would have required larger budgetary commitments than what Germany currently offers.

A significant and substantial budget reorientation is necessary and also feasible. We recommend that the regular defence budget is increased to €80 billion as of next year (2025) to create room for an additional €28 billion worth of investments in equipment. This budgetary increase is a necessary structural shift in the budget towards long-term higher spending on defence, which should not be permanently deficit funded. If an immediate adjustment is not possible, at least a clear path forward with significant annual increases is necessary, if only to preserve the political credibility of an otherwise non-serious financial planning. Moreover, the investment needs are so large that a second Sondervermögen to fill the major gaps in capabilities will be needed by 2026 or 2027 at the latest. Finally, we propose quickly creating an EU debt vehicle to fund the European Sky Shield Initiative. Steinbach and Wolff (2024) also make this suggestion and argue that a construction similar to the EU Corona debt fund is legally feasible. The overall budgetary adjustment for Germany is in the order of magnitude of around 1% of GDP – an adjustment that is feasible and pales in comparison with the budget adjustments that Europe's South faced during the euro area crisis. More importantly, it is an adjustment that, if done well, should increase trend growth as it shifts spending from consumption to investments into security and innovation for defence – with positive net effects on growth.

3 – Lowering costs: Many of the products ordered have high unit prices. These high costs are, in part, a reflection of the small number of units ordered, which results in limited economies of scale. However, they also reflect the European focus on gold-plating equipment with substantial special wishes by military leaders and that of the political system on catering to specific interests – instead of focusing efforts on building up scale and efficiency. The war in Ukraine proves that Europe cannot afford to neglect such a build-up of scale and efficiency. **As domestic defence budgets increase, quantities of units ordered should also increase, allowing unit prices to fall.**

An additional, obvious way of increasing the number of units ordered is by further integrating the European defence market. Moving beyond its current fragmentation should be feasible as it arguably reflects national industrial policy preferences rather than genuine security issues.

Europe has 12 different types of tanks, not because the security requirements of the 27 countries are so vastly different, but rather because countries want local industry to contribute to defence production, no matter how small of a role it may play. While obstacles to European defence market integration are well understood (see e.g. Fiott, 2024), a rapidly increasing market should allow countries to overcome some of the typical vested interests that stand in the way of increasing market integration. An increasing market can allow countries and companies to move from a zero-sum logic to a growing market logic. To decrease unit prices, Europe must also consider the trade-off between when **export restrictions** are legitimate and when they lead to unnecessary limitations on production numbers. **Integrating European defence markets should also increase competition**, thereby eliminating the privileged status national producers of defence equipment have in national procurement offices, **and will be politically feasible relative to vested interests thanks to the growing market.**

4 – Reforming procurement: German procurement processes remain slow and bureaucratic. This report has not studied in detail the procurement office in Koblenz, which has been subjected to repeated criticism during the last decades and for which many attempts at reform have failed. Numerous reports, such as the recent report from the advisory committee of German Ministry for Economic Affairs and Climate Action (2023), document how bureaucratic processes and risk aversion prevent agility and speed in procurement. The report raises the question of whether excessive parliamentary involvement possibly leads to inefficiencies and whether rules regarding the incorporation of small and medium enterprises (SMEs) in projects slow down order deliveries. Finally, the report critiques a pro-EU procurement rule with protectionist effects vis-à-vis third countries. Beyond the bureaucracy itself and broader administrative–political processes, we consider it important to reassess whether **procurement contracts** themselves provide enough incentives for companies to be cost effective (see for example Streb and Streb, 1998). Market structure matters in the defence market, due to the very limited number of buyers and sellers. **Instead of intervening in markets by creating a war economy, Europe and Germany should champion free market forces with competition, procurement with minimal domestic home bias, and more cross-border purchases.**

5 – Developing technology: Germany’s procurement activities also seem to suffer from a technology problem. In the procurement activities we study, we could not detect a clear sense of an overall technological direction corresponding to the changing nature of warfare, as demonstrated on the Ukrainian battlefield. Equipping Germany’s armed forces sustainably with state-of-the-art technology, for example in drone warfare, requires agile procurement processes. It probably also requires access to a wide variety of agile companies that produce mass dual use products at cheap prices.

Germany’s procurement priorities have shifted and the mix of purchases should indeed be carefully considered. In our study, we find that Germany and NATO put strong emphasis on air forces, with around 18% of the value of German military equipment stock in that category. A similar pattern is observed in the European defence industry: in 2022, the annual turnover of

military aerospace companies accounted for around 20%²⁸ of the revenues of the entire (civilian and military) aerospace and defence sector, which equalled €260 billion. In our procurement data, some rebalancing is visible: out of total orders, some 11% was spent on the air force from 2022 to now (down from 31% in 2020–2021). Without ourselves commenting on questions related to military doctrine, we strongly suggest the mix of purchases deserves thoughtful and continued debate by military planners at a moment when strong land forces, that are amply armed with missiles and drones, have been shown to be central to warfare.

6 – Fostering investment: Europe must reassess its written and unwritten guidance to capital markets to ensure adequate funding for all defence companies in the context of ESG investing. Anecdotal evidence on **funding constraints**, for example Prem (2022), suggests that funding for new production sites is not only constrained by uncertain budgetary outlooks, but also by hesitant investors fearing public backlash to their investments. In addition, policymakers should indeed **review all other regulatory and practical obstacles to military production**.²⁹

In need of a long-term strategy:

Some commentators have been urging Europe to adopt a sort of war economy. Popescu (2024) and Boone and Popescu (2024) suggest that Europe should adopt an EU defence production act similar to the US Defence Production Act, which gives the US President substantial powers to direct critical material as well as financial flows to the production of defence goods. Putting aside the difficulties of creating such a scheme in a fragmented European polity and a fragmented defence market, we are sceptical of such command-type economic policy guidance. At the same time, the current approach is clearly also unsatisfactory. Sluggish demand for defence products combined with half-hearted increases in production capacity leads to the overall result that capacities will fall short of what is needed for decades to come.

Instead of a war economy, Germany and Europe must develop a rearmament strategy that prioritises **long-term commitments** to defence spending and moves beyond current purchasing patterns, which appear rather ad-hoc and seem to lack a longer-term strategy or any significant coordination across Europe. The starting point needs to be a realistic assessment of the scope and size of the challenge that is combined with a clear political will across Europe to take care of its security on its own. Second, military planners – either in the context of a European NATO or in a more EU-driven mechanism – need to assess what the capabilities are and what gaps need to be filled. In a third step, these assessments must be translated into a viable armament strategy. Although Germany has been rearming in the last few years, our study shows that quantities are small.

In our view, the assessment by Germany's defence minister Boris Pistorius that Russia could soon have the capacity to attack NATO is correct – but such a prospect is not yet reflected in

²⁸ According to the ASD annual report 2023. https://umbraco.asd-europe.org/media/jo3nxdjg/facts-figures-2023_web.pdf?rmode=pad&v=1da22c207d9e050

²⁹ For example, local protests have been significantly slowing the expansion of ammunition production. <https://www.waz.de/wirtschaft/article241651532/Weitere-Munitionsfabrik-Rheinmetall-im-Wettruensten-mit-Putin.html>

policy. The current approach to armament will clearly not suffice. We concur with the German defence minister that Russian capabilities are rapidly increasing. What is worse, should Ukraine be forced into a ceasefire either by diplomatic pressure from a Trump administration or Russian pressure on the battlefield, Russian military capacities would then increase even more quickly. There is thus no time to waste. Tracking procurement over the last two and a half years has not reassured us that the problem is being addressed with the necessary urgency.

A long-term rearmament strategy that provides long-term demand signals would solve the conundrum of insufficient supplies. Profit seeking companies have time and again shown that they can deliver the best products in the most efficient way and do so rapidly. However, they can only do so if long-term demand is assured. Although directing resources to defence companies via a war economy would increase military production, such a strategy would be highly costly and probably unpopular for society, given that some companies would be forced to reduce their production of consumer goods. Instead, **a clear and sustained increase in demand over the long term will create the necessary supplies by market forces.** Policymakers should focus on increasing demand for military equipment. Moreover, by moving decisively beyond national markets towards a more **integrated European defence market**, there are significant efficiencies to be unlocked in European defence supply chains, **especially in the Central and Eastern European** member states, where there is a strong tradition of weapons production and unit labour costs remain relatively low. At the same time, the European public largely supports defence integration, as documented by surveys (Burgoon et al., 2023).³⁰

Finally, a long-term armament strategy needs a clear technology focus to meet military threats. Such a focus would also be beneficial to the wider economy. In our report, we highlight one such issue: the threat posed by the growing arsenal of Russian hypersonic weapons, to which a credible deterrent is a critical part of the necessary rearmament. Germany could, for example, fund a major dual use programme for missiles with hypersonic capabilities in cooperation with key European partners like France.

³⁰ See also Graf (2020) for an elaborate discussion as well as Merand and Angers (2014).

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ANNEX

ANNEX A2

This Annex is composed of three sections. The first section outlines in detail the methodology of Chapter 2, which assesses Russian production since October 2022. The second section includes further details on Russian production, including monthly production, and detailed information on artillery type. The final section presents qualitative data on exports to demonstrate the resilience of Russian production.

Methodology

Chapter 2 presents a novel methodology for estimating Russian production and its change over time. The methodology centres on weapon systems, although it also covers key munitions (shells, rockets, and loitering munitions). Ground warfare is the dominant feature of the Ukrainian battlefield and would be dominant in any hypothetical future conflict on NATO's eastern flank. NATO doctrine preferentially emphasises airpower for fires, unlike the more holistic Russian approach. However, open conflict between NATO and Russia implies that NATO (air) forces would be operating in a highly contested environment due to significant Russian capabilities in 4th/5th generation fighters; an integrated air defence network that includes long-range SAMs and passive radar; an electronically degraded battlespace; and most critically, the vulnerability of NATO logistics nodes, command and control facilities, and air bases to salvoes of combat-proven Russian supersonic and hypersonic missiles. This means that NATO would be highly unlikely to quickly attain air superiority. Therefore, any manoeuvre without air superiority would become very risky, and the use of NATO airpower for fires would be restricted. Key elements in a theory of victory would therefore be the same as in the war in Ukraine: ground force generation and sustainment.

The chaotic first phase of the Russian invasion of Ukraine ended in October 2022, following Ukrainian victories at Izyum and Kherson and the concurrent Russian decision to mobilise. Since then, the Russian units fighting in Ukraine have been gradually brought to a capacity that ensures these units are sustainably combat effective. The continued combat effectiveness of Russian forces can be qualitatively assessed by examining their performance since October 2022, which includes the capture of Bakhmut in May 2023, the defeat of the 2023 Ukrainian summer counteroffensive, the capture of Avdiivka in February 2024, the reduction of the Ukrainian bridgehead over the Dnieper in Kherson, and the 2024 summer offensive in the Donbas. Whether this latest operation will result in a Russian strategic breakthrough is an open question. Nonetheless, Russian forces have been continually on the offensive along the 1,200 km frontline and advance on multiple axes in eastern Ukraine since October 2023. This indicates that on the whole, the Russian forces in Ukraine remain combat effective due to continual replenishment of losses of personnel and systems.

The Russian military has three types of top-level formations: Combined Arms Armies (CAA), Army Corps (AC), and separate Divisions. Given the Kremlin's stated and evident goal of prosecuting the war to a decisive military victory, it can be assumed that Russian defence production is allocated with the following priority:

1. **Force sustainment (in theatre):** the formations fighting in the Ukrainian theatre have top priority as their performance is directly contingent on the continuous supply of replacement materiel and personnel.
2. **Force generation:** newly created formations of the Russian military, in this case the 25th CAA and the 40th and 44th AC. These simplified, infantry-centric formations are intended to serve as reserves for the war, without dipping into other, more sophisticated existing CAAs that are not currently in theatre.
3. **Force sustainment (out of theatre):** routine training and maintenance for Russian units that are not currently fighting in Ukraine. Russian units that are engaged in other military campaigns, such as fighting in Syria, would take precedence over units within Russia proper.
4. **Exports:** although defence exports are a key part of Russian influence and a prime economic sector, prosecuting the war takes precedence. Two observations are relevant: the US has also had to scale back exports to support Ukraine (Miller et al., 2024), and the scale and speed of Russian contract fulfilment is an indicator to what extent priorities 1–3 are met.

The chapter assesses production from October 2022 on. This is due to the haphazard, ad-hoc nature of the Russian military campaign prior to October 2022, characterized by poor performance, high casualty rates, lack of infantry reserves, and a wholly unsustainable rate of materiel consumption. For instance, Russian forces fighting in the Donbas in the summer of 2022 expended 60,000 shells a day, which would translate to a yearly consumption of nearly 22 million, or more shells than the total world production. However, with consequential defeats at Izyum and Kherson, the Kremlin made the politically challenging decision to commit fully and systematically to prosecuting the war as an industrial one. Although mobilisation in the fall of 2022 was the first visible sign, a significant ramp-up in defence production also began and is ongoing as of July 2024.

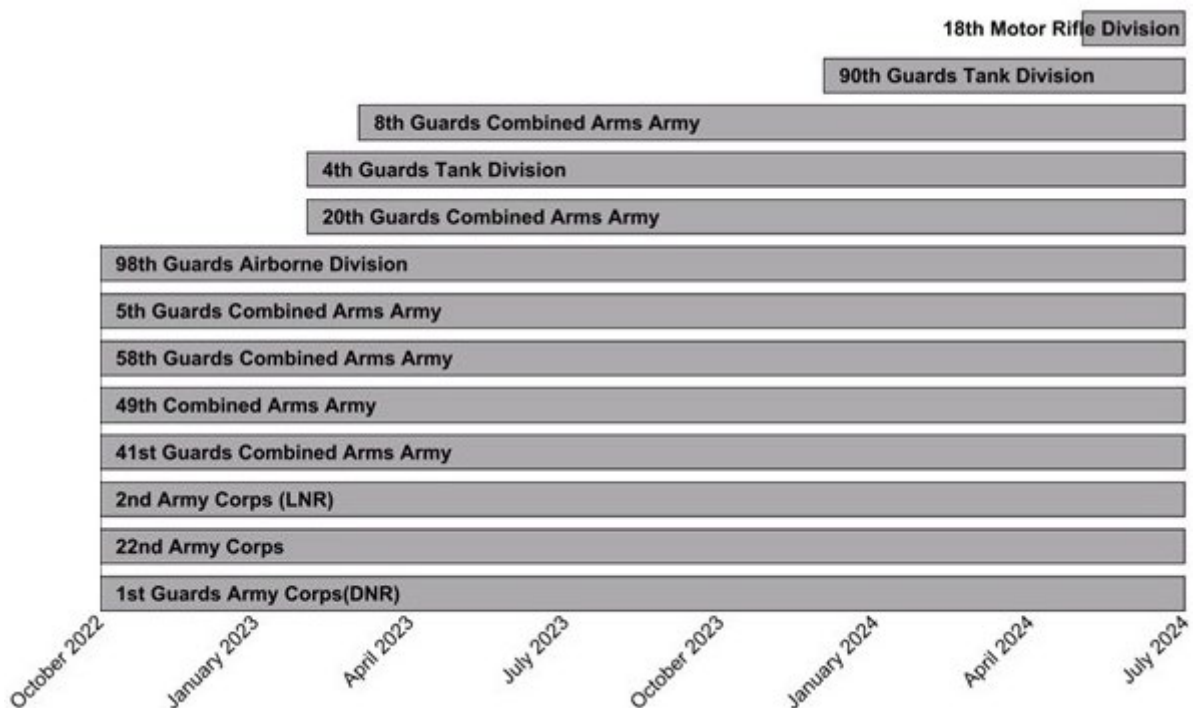
The order of battle (ORBAT) of a military campaign is the list of formations fighting in that campaign, in this case, the Russian formations in theatre in Ukraine. Taking the composition of each CAA, AC, and division in terms of brigades and regiments, and then further breaking down those units into their constituent battalions, gives us the total count of battalions of each type (motor rifle, tank, artillery, etc.) in theatre. In turn, taking the standardised tables of organisation and equipment (TOE) of each battalion type gives us the total maximum possible number of each combat vehicle in theatre.

Established assumptions about daily attrition rates (Dupuy 1995; Epstein 1988) appear to hold firm in this war, especially once the chaotic initial phase ended with the battles of Izyum and Kherson. We assume top-level Russian formations such as Army Corps and Combined Arms Armies sustain a cumulative monthly attrition rate of 5.8%, weighted lower for systems in the rear (artillery, MLRS, and SAM), and further slightly weighted by the proportion of Russian formations that are primarily engaged in positional (neutral), offensive (higher), or defensive (lower) operations. It should be noted that while attrition rates have remained relatively constant from World War II onwards, typical combats in Ukraine take place at a smaller scale and

involve fewer troops (companies and battalions rather than brigades and divisions) than previous conflicts used for modelling casualties such as the Yom Kippur War, meaning that we expect attrition to be slightly lower. Therefore, we can estimate the monthly production rate needed to maintain all Russian formations as combat effective by taking the weighted percentage of systems per battalion that would be attritted every month.

Finally, three new top-level formations have been created in May 2023: the 25th CAA and the 40th and 44th AC. These are simplified, infantry-heavy formations. Since their TOE is also known, we can estimate the monthly production rate needed to make them combat effective by no later than October 2024. These three formations give the Kremlin a substantial new reserve pool that does not draw on existing formations not currently fighting in Ukraine, and a significant asset for an autumn-winter 2024 or spring 2025 offensive.

Figure A2.1:
Timeline of Russian formations in Ukraine, Russian order of battle (ORBAT) in the Ukrainian theatre, timeline since Oct. 2022



Source: Own calculations, based on open-source intelligence.

Order of battle (ORBAT) in the Ukrainian theatre, composition by top-level formation

Note: every Combined Arms Army includes one electronic warfare (EW) regiment and one recon battalion. Every separate division includes one recon battalion. Each motor rifle brigade and battalion include one NBC (Nuclear, biological, and chemical defence) unit that fields the TOS heavy flamethrower MLRS.

22nd Army Corps

- 126th coastal defence brigade (*missile unit for defence of Crimea only*)
- 127th recon brigade
- 8th artillery regiment
- 1096th air defence regiment

20th Guards Combined Arms Army

- 3rd motor rifle division
- 144th motor rifle division
- 236th artillery brigade
- 448th ballistic missile brigade
- 53rd air defence brigade

8th Guards Combined Arms Army

- 20th motor rifle division
- 150th motor rifle division
- 238th artillery brigade
- 47th ballistic missile brigade
- 78th air defence brigade

5th Guards Combined Arms Army

- 127th motor rifle division
- 60th motor rifle brigade
- 57th motor rifle brigade
- 155th naval infantry brigade
- 40th naval infantry brigade
- 305th artillery brigade
- 20th ballistic missile brigade
- 8th air defence brigade

49th Combined Arms Army

- 205th motor rifle brigade
- 34th mountain motor rifle brigade
- 227th artillery brigade
- 1st ballistic missile brigade
- 90th air defence brigade

58th Guards Combined Arms Army

- 19th motor rifle division
- 42nd motor rifle division
- 136th motor rifle brigade
- 49th airborne brigade
- 291st artillery brigade
- 12th ballistic missile brigade
- 100th recon brigade

1st Guards Army Corps (DNR: former Donetsk People's Republic separatist units)

- 1st motor rifle brigade
- 5th motor rifle brigade
- 9th motor rifle brigade
- 110th motor rifle brigade
- 114th motor rifle brigade
- 132nd motor rifle brigade
- 14th artillery brigade
- 87th rifle regiment
- 10th tank regiment
- 23rd air defence brigade

2nd Army Corps (LNR: former Luhansk People's Republic separatist units)

- 4th motor rifle brigade
- 6th motor rifle brigade
- 7th motor rifle brigade
- 85th motor rifle brigade
- 88th motor rifle brigade
- 123rd motor rifle brigade
- 2nd artillery brigade

41st Guards Combined Arms Army

- 35th motor rifle brigade
- 74th motor rifle brigade
- 55th mountain motor rifle brigade
- 120th artillery brigade
- 119th ballistic missile brigade
- 61st air defence brigade
- 57th heavy artillery brigade

18th Motor Rifle Division

- 79th motor rifle regiment
- 275th motor rifle regiment
- 280th motor rifle regiment

- 11th tank regiment
- 11th artillery regiment

90th Guards Tank Division

- 6th tank regiment
- 80th tank regiment
- 239th tank regiment
- 228th motor rifle regiment
- 400th artillery regiment
- 288th air defence regiment

4th Guards Tank Division

- 12th tank regiment
- 13th tank regiment
- 423rd motor rifle regiment
- 275th artillery regiment
- 538th air defence regiment

98th Guards Airborne Division

- 217th airborne regiment
- 299th airborne regiment
- 331st airborne regiment
- 1065th artillery regiment
- 5th air defence regiment

Force generation – formations stood up in May 2023, but remain in reserve

Note: every Combined Arms Army includes one EW regiment and one recon battalion.

25th Combined Arms Army

- 67th motor rifle division
- 164th motor rifle brigade
- 169th motor rifle brigade
- 11th tank regiment
- 73rd artillery brigade

40th Army Corps

- 47th motor rifle brigade
- 144th motor rifle brigade

44th Army Corps

- 72nd motor rifle division
- 128th motor rifle brigade

Tables of organization and equipment (TOE)

Divisions

Motor rifle: 3 motor rifle regiment, 1 tank regiment, 1 artillery regiment, 1 air defence regiment

Brigades

Motor rifle (*including mountain*): 3 motor rifle battalion, 1 tank battalion, 2 artillery batteries, 1 MLRS battery, 2 SHORAD batteries, 1 recon battalion

Naval infantry: 2 motor rifle battalion, 1 tank battalion, 2 artillery batteries, 1 SHORAD battery

Airborne: 4 airborne battalion, 1 artillery battery, 2 SHORAD batteries, 1 recon battalion

Artillery: 6 artillery batteries, 3 MLRS batteries

Heavy artillery: 6 artillery batteries

Air defence: 4 SHORAD batteries, 8 long-range SAM batteries

Regiments

Motor rifle: 3 motor rifle battalion, 1 tank battalion, 2 artillery battery, 2 SHORAD batteries, 1 recon battalion

Tank: 3 tank battalion, 2 artillery batteries, 2 SHORAD batteries, 1 recon battalion

Airborne: 3 airborne battalion, 1 artillery battery, 2 SHORAD batteries, 1 recon battalion

Artillery: 4 artillery batteries, 2 MLRS batteries

Air defence: 4 SHORAD batteries, 2 long-range SAM batteries

Table A2.1:
Battalion/battery composition, Systems per battalion/battery

	Tank (MBT)	Other armoured vehicle (IFV/APC/IMV)	Artillery (gun)	Artillery (rocket MLRS)	Short-range air defence (SHORAD)	Medium and long-range air defence
Motor rifle		45				
Tank	30					
Artillery			16			
Rocket				8		
SHORAD					2	
SAM						4
Recon		6				
Airborne		30				

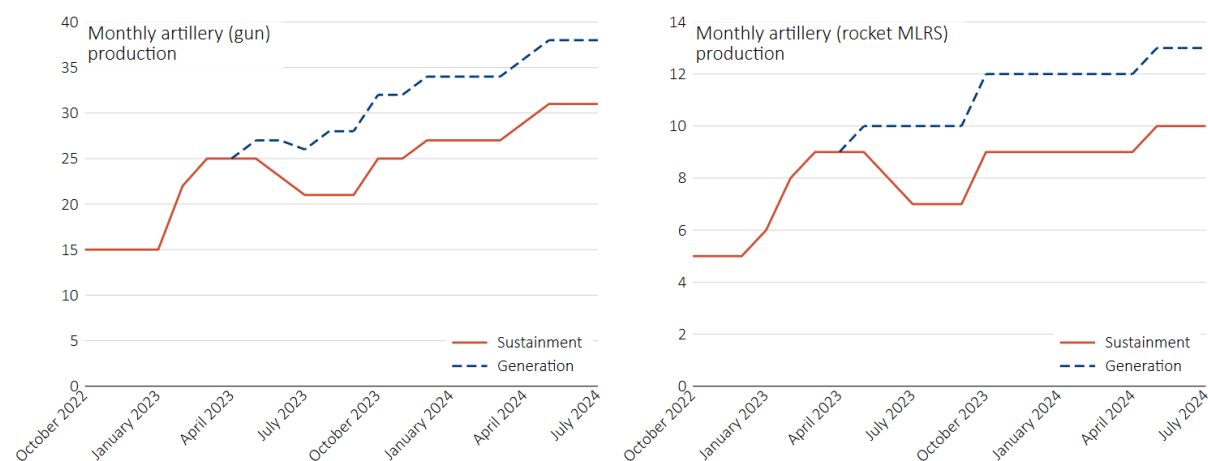
Note: Own calculations, based on methodology detailed in Annex A2.

Table A2.2:
Monthly Russian production of key weapon systems, Monthly production, overall

Quarter	Tank (MBT)	Other armoured vehicle (IFV/APC/IMV)	Artillery (gun)	Artillery (rocket MLRS)	Short-range air defence (SHORAD)	Medium and long-range air defence	Lancet loitering munition
Oct. 2022	41	195	15	5	3	2	28
Nov. 2022	41	195	15	5	3	2	31
Dec. 2022	41	195	15	5	3	2	34
Jan. 2023	43 1027	203 4151	15 321	6 118	3 75	2 42	37 885
Feb. 2023	67	284	22	8	4	3	39
Mar. 2023	76	327	25	9	4	3	52
Apr. 2023	76	327	25	9	4	3	61
May 2023	82	345	27	10	5	4	64
Jun. 2023	85	348	27	10	6	4	68
Jul. 2023	86	344	26	10	8	4	75
Aug. 2023	92	361	28	10	8	4	77
Sep. 2023	92	361	28	10	8	4	87
Oct. 2023	105	414	32	12	8	4	98
Nov. 2023	105	414	32	12	8	4	112
Dec. 2023	118	423	34	12	9	4	115
Jan. 2024	120 1475	430 5399	34 428	12 146	9 100	4 46	134 2208
Feb. 2024	120	430	34	12	9	4	148
Mar. 2024	120	430	34	12	9	4	158
Apr. 2024	125	451	36	12	9	4	166
May 2024	131	479	38	13	9	4	181
Jun. 2024	131	479	38	13	9	4	188
Jul. 2024	131	479	38	13	9	4	193

Note: Own calculations, based on methodology detailed in Annex A2.

Figure A2.2:
Monthly artillery production by type



Note: The red solid Sustainment line shows the production rates needed to keep Russian units at combat efficiency, given the units in theatre and the nature of the fighting. The blue dashed Generation line shows the extra production rates needed to fully equip the three new armies (25th Combined Arms Army and the 40th and 44th Army Corps) created by Russia in May 2023 within a reasonable timeframe (18 months), so that these formations are combat effective by October 2024.

Source: Own calculations, based on methodology detailed in Annex A2.

Unlike tanks, where the main bottleneck is the availability of hulls, the main bottleneck for gun artillery are barrels, which wear down rapidly in battlefield conditions. Russia introduced the Floks 120mm wheeled mortar and Malva 152mm wheeled howitzer on the battlefield in 2023. The Russian military appears to have reached similar conclusions to NATO on artillery design and therefore aims to eventually shift to wheeled artillery, which would remove competition for hulls between tanks and the artillery, aside from a limited number of high-end Koalitsiya-SV tracked howitzers. The time-efficient production method for artillery and tank barrels relies on specialised radial forging machines. Soviet annual production in 1990 for large barrels was estimated at 14,000 (CIA, 1982); even a fraction would be sufficient to meet the demands of Russian forces in Ukraine. Nonetheless, as Russian forces rely primarily on artillery for firepower, issues in consistent shell procurement and demands for greater range and accuracy are likely, leading to a shift in the balance between gun and rocket artillery (MLRS). Russia fields a wide variety of MLRS systems, and the most modern one, the Tornado-S, is similar to the American HIMARS in capabilities.

Exports

Russia remains a major arms exporter, war notwithstanding, especially to the lower-cost arms market (Bergmann et al., 2023). The fulfilment of existing contracts and the pace and composition of new contracts are relevant benchmarks for Russian defence production, considering we assess exports as the least priority in the allocation of production. Moscow would only export systems if they were not necessary for domestic force generation and sustainment, including a potential direct confrontation with NATO.

The state of several high-profile orders offers a further glimpse into production. After delays in 2022, Russia resumed deliveries of the S-400 to India, despite several probable losses to Storm Shadow and ATACMS missile attacks. Deliveries were also initiated to Iran in 2024, coupled with high-end EW systems. Algeria is Moscow's most reliable client in Africa, and deliveries of a variety of armoured vehicles on the T-72 tank chassis continue. After a lengthy selection process, Kazakhstan opted for Sukhoi for modernizing its multirole aircraft fleet, preferring the Russian offer to the French on lead time and cost grounds. Cuba reportedly ordered Geran drones. Finally, sparse reports indicate that in summer 2024, Malian and Nigerien forces began using Russian glide bombs. In general, Russia remains a major presence in non-Western defence expos, such as IDEX 2023. These data points indicate that for a variety of systems, Russian production is stable enough to provide sustainment for the war in Ukraine.

ANNEX A3

We use the annual ‘Military Balance’ publications of the International Institute for Strategic Studies (IISS). Each book provides an assessment of military capabilities at the country level by providing a comprehensive list of deployable weapons, i.e., weapons that are ready-to-use.³¹ First, we present the detailed numbers for the four countries we study.

Table A3.1:
Germany’s stocks of key weapon systems over time

	1992	2004	2013	2019	2020	2021
Main Battle Tanks	6684	2398	322	323	323	339
Leopard 1	2084	670	0	0	0	0
Leopard 2	2083	1728	322	323	323	339
Soviet Tanks	1868	0	0	0	0	0
Other	649	0	0	0	0	0
Light Tanks	118	343	128	175	175	175
Wiesel	118	343	128	175	175	175
Infantry Fighting Vehicles	3250	2122	395	651	710	674
Marder	2100	2122	390	383	376	324
Puma	0	0	5	268	334	350
BMP-1/BMP-2	1150	0	0	0	0	0
Armoured Vehicles	12977	3646	2114	1933	2067	2067
M-113	2902	2067	296	162	37	37
Fuchs, Eagle IV/V	0	1023	950	1012	1004	1004
Soviet BTRs and BRDMs	7695	0	0	0	0	0
Other	2380	556	868	759	1026	1026
Howitzers	3214	978	130	121	121	121
PzH 2000	0	165	130	121	121	121
M-109	573	499	0	0	0	0
FH-70	216	196	0	0	0	0
M-110	221	0	0	0	0	0
Soviet Howitzers (2S1, 2S3, M-30, M-46, D-20)	1844	0	0	0	0	0
Other	360	118	0	0	0	0
Long Range Anti Aircraft	300	0	14	30	30	30
Patriot launchers	288	NA	14	30	30	30
S-200C Vega	12	0	0	0	0	0
Short Range Anti Aircraft	680	0	2	12	12	12
Mantis	0	0	2	12	12	12
Roland	238	0	0	0	0	0
Soviet SAM launchers (KUB/Sterla)	226	0	0	0	0	0
MIM-23 HAWK	216	0	0	0	0	0
Anti Aircraft Guns	3295	1509	0	0	0	0
Gepard	432	354	0	0	0	0
Rh 202	1989	1155	0	0	0	0
Soviet ZU/ZSU	426	0	0	0	0	0
Other	448	0	0	0	0	0
MLRS	237	200	55	41	41	41
M270	0	0	0	41	41	41
unknown MLRS	33	150	55	0	0	0
LARS	204	50	0	0	0	0
Combat Aircraft	553	423	205	228	228	226
Eurofighter Typhoon	0	8	101	140	140	138
Tornado	161	262	104	88	88	88
Phantom II	223	152	0	0	0	0
Other	169	1	0	0	0	0

Source: IISS (1992, 2004, 2014, 2020, 2021, 2022).

³¹ There are some cases when IISS Military Balance reports weapons and equipment ‘held away from front-line units’ but this is always marked as ‘in store’ and is not considered in the current note.

Table A3.2:
France's stocks of key weapon systems over time

	1992	2004	2013	2019	2020	2021
Main Battle Tanks	2001	614	254	222	222	222
Leclerc	0	370	254	222	222	222
AMX-30	2001	244	0	0	0	0
Light Tanks	171	28	28	0	0	0
VBC-90	28	28	28	0	0	0
AMX-13	143	0	0	0	0	0
Infantry Fighting Vehicles	1141	701	786	872	850	951
AMX-10RC	1141	701	256	247	245	245
VBCI	0	0	530	625	605	706
Armoured Vehicles	5101	5484	5055	3828	3988	4072
VAB	3840	3700	3126	2255	2248	2208
VBL	240	1442	1594	1424	1418	1416
Other	1021	342	335	149	322	448
Howitzers	786	375	120	89	88	88
AMX-GCT/AU-F1	253	273	0	0	0	0
CAESAR	0	5	77	77	76	76
Other	533	97	43	12	12	12
Long Range Anti Aircraft	180	98	14	30	30	30
Roland	180	98	0	0	0	0
SAMP/T	0	0	0	40	40	40
Medium Range Anti Aircraft	69	26	0	0	0	0
MIM-23 HAWK	69	26	0	0	0	0
Short Range Anti Aircraft	150	331	0	24	24	24
Mistral	150	331	0	0	0	0
Crotale NG	0	0	0	24	24	24
MLRS	30	61	26	13	13	13
M270	0	0	0	13	13	13
unknown MLRS	30	61	26	0	0	0
Combat Aircraft	215	222	238	227	227	228
Mirage-2000	0	158	153	107	107	112
Mirage F-1	173	54	5	0	0	0
Other	42	10	80	120	120	116

Source: IISS (1992, 2004, 2014, 2020, 2021, 2022).

Table A3.3:
United Kingdom's stocks of key weapon systems over time

	1992	2004	2013	2019	2020	2021
Main Battle Tanks	1276	543	227	227	227	227
Challenger 2	426	386	227	227	227	227
Challenger 1		156	0	0	0	0
Chieftain	850	1	0	0	0	0
Light Tanks	627	464	200	176	176	176
Scimitar	315	327	200	176	176	176
FV101 Scorpion	312	0	0	0	0	0
Sabre	0	137	0	0	0	0
Infantry Fighting Vehicles	605	575	350	388	388	388
MCV-80 Warrior	605	575	350	0	0	0
FV510 Warrior	0	0	0	388	388	388
Armoured Vehicles	5626	4054	2763	2586	2590	2579
AIFV	0	1675	0	0	0	0
FV103 Spartan	525	597	275	252	252	252
FV432	2013	1121	0	0	0	0
Saxon	1138	649	0	0	0	0
BvS-10 Viking	0	0	18	99	99	99
FV430 Bulldog	0	0	880	409	409	409
Mastiff	0	0	420	396	396	396
Foxhound	0	0	330	399	399	399
Other	1950	12	840	1031	1035	1024
Howitzers	723	344	233	215	215	215
AS90	8	178	89	89	89	89
L118 Light gun	212	166	144	126	126	126
FV433 Abbot	200	0	0	0	0	0
M-109	111	0	0	0	0	0
Other	192	0	0	0	0	0
Short Range Anti Aircraft	200	192	74	74	74	74
FV4333 Stormer with Starstreak	0	135	60	60	60	60
Rapier	200	57	14	14	14	14
MLRS	47	63	35	35	35	35
M270	0	0	35	35	35	35
unknown MLRS	47	0	0	0	0	0
Combat Aircraft	274	510	285	162	162	167
Typhoon/Tornado	198	254	220	144	144	144
Jaguar	53	62	0	0	0	0
Harrier	0	79	62	0	0	0
Hawk	0	115	0	0	0	0
Buccaneer	23	0	0	0	0	0
F-35B	0	0	3	18	18	23

Source: IISS (1992, 2004, 2014, 2020, 2021, 2022).

Table A3.4:
Poland's stocks of key weapon systems over time

	1992	2004	2013	2018	2020	2021
Main Battle Tanks	2880	947	893	637	808	797
T-72	785	586	533	158	329	318
T-55 and PT-76	2095	0	0	0	0	0
PT-91 Twardy	0	233	232	232	232	232
Leopard 2A4	0	128	128	142	142	142
Leopard 2A5	0	0	0	105	105	105
Infantry Fighting Vehicles	1471	1281	1867	1636	1611	1611
BMP-1	1409	1248	1297	1277	1252	1252
BMP-2	62	0	0	0	0	0
Rosomak IFV	0	0	570	359	359	359
BRM-1	0	33	0	0	0	0
Armoured Vehicles	1437	468	436	733	828	828
BRDM-2	685	435	237	369	369	369
Rosomak APC	0	0	0	211	300	300
Other	752	33	199	153	159	159
Howitzers	2222	1014	401	427	394	410
2S1 Gvozdika	0	533	290	292	227	227
M-77 Dana	111	111	111	111	111	111
Krab	0	0	0	24	56	72
Other (Soviet)	2111	370	0	0	0	0
Long Range Anti Aircraft	250	125	1	1	1	1
2K11 Krug	0	75	0	0	0	0
S-200C Vega	0	50	1	1	1	1
S-125/S-200	250	0	0	0	0	0
Short Range Anti Aircraft	160	316	81	81	98	81
SA-9 Gaskin	0	232	0	0	0	0
9K33 Osa-AK (SA-8 Gecko)	0	64	64	64	64	64
S-125 Neva	0	20	17	17	34	17
GROM Poprad	0	0	0	0	0	0
unspecified soviet SAM system	160	0	0	0	0	0
MLRS	262	249	180	180	179	179
BM-21	232	219	75	75	75	75
RM-70	30	30	30	30	29	29
WR-40 Langusta	0	0	75	75	75	75
Combat Aircraft	332	242	106	98	94	94
MiG-21	254	99	0	0	0	0
MiG-23	37	0	0	0	0	0
MiG-29	9	45	32	32	28	28
MiG-17	24	0	0	0	0	0
Su-20	8	0	0	0	0	0
Su-22	0	98	26	18	18	18
F-16	0	0	48	48	48	48

Source: IISS (1992, 2004, 2014, 2020, 2021, 2022).

Accounting for quality and value

Simple absolute numerical comparison can be misleading due to differences in weapon quality. Thus, to ensure comparability across different weapon designations and types, we use a relative measure developed by the Stockholm International Peace Research Institute (SIPRI) for its Arms Transfers Database.

The trend-indicator value (TIV) developed by SIPRI is used to assess the volume of the international arms trade and therefore does not reflect the monetary value of each weapon, which varies considerably depending on the context. Instead, the TIV focuses on the production costs of the core set of weapons, which are then extrapolated to other weapons by comparing basic characteristics such as size, power, type of electronics, etc.

Although this measure was developed for arms transfers, it can be applied to other contexts. In our case, we use it to compare military capabilities between countries, as it allows weapons systems to be compared based on their objective parameters, rather than the monetary value of production costs, which vary significantly between countries.

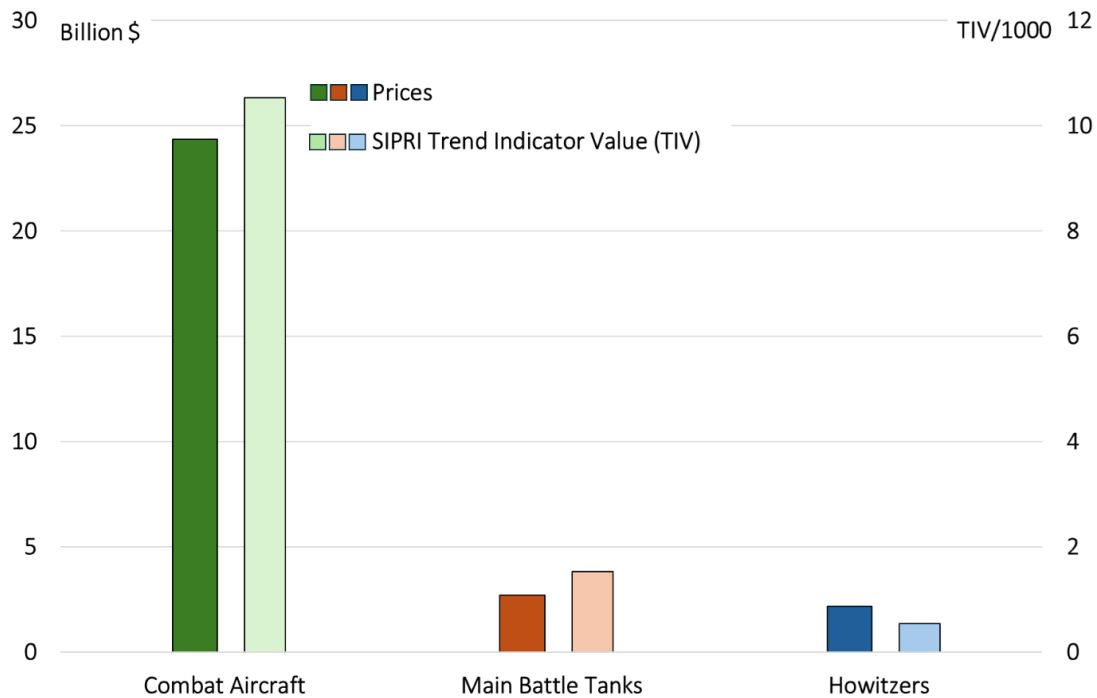
In cases where we cannot find a TIV for a particular weapon in a country's inventory, we take the value of the closest variant. However, this was only done for a small number of weapons in our calculations, so it does not affect the final results.

Next, we use production costs to ensure comparability in the cross-country comparison. Thus, we do not focus on the budgetary burden or the financial value of arms procurement, but rather on estimated costs that are independent of country-specific characteristics and serve as a proxy for arms quality.

Using the calculated relative values, we first ensure that our estimates of German military capabilities in dollars, presented in Section 3 of this report, are consistent. Figure A3.1 shows no significant difference between monetary and relative values when comparing the importance of combat aircraft, main battle tanks, or howitzers.

Figure A3.2 uses relative values to show the composition of German, French, British, and Polish military capabilities in six categories in 2021. As discussed in Chapter 3 of this report, combat aircraft is the category in which the observed countries have placed the most emphasis. This is followed by main battle tanks and other armoured vehicles. Anti-aircraft systems and artillery receive the least emphasis.

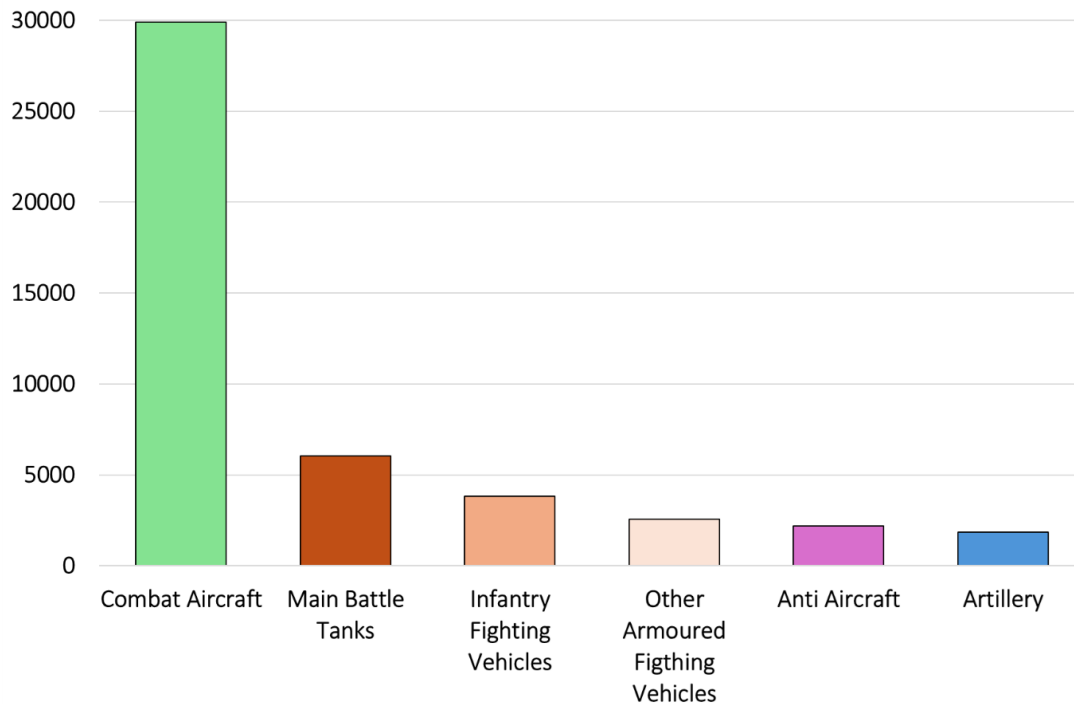
Figure A3.1:
German military capabilities in three categories (2021): Real \$ value vs TIV value from SIPRI



Note: The figure shows and compares the dollar value and SIPRI Trend-Indicator-Value (TIV) of German military stock in 2021 for fighter aircraft, main battle tanks, and howitzers. For the sake of comparability, we do not distinguish between the age and quality of the weapon when calculating the dollar value. Thus, all Leopard 2 tanks have the price of a new Leopard 2A7 tank. The prices are based on the most recent sources of public announcements published on <https://bmvg.de/>. The only exception is the Tornado fighter jet, whose price comes from the SIPRI Trade Register that shows the price for the procurement of a used Tornado fighter jet to capture its age. All prices are deflated to \$2022 using the BEA GDP deflator for National Defence (BEA's Table 1.1.4. Price Indexes for Gross Domestic Product).

Source: Own calculations. Data on stocks is from IISS (2021), price data is from SIPRI and various public sources, and TIV estimates are from SIPRI.

Figure A3.2:
German, French, British, and Polish military capabilities in six categories (2021)



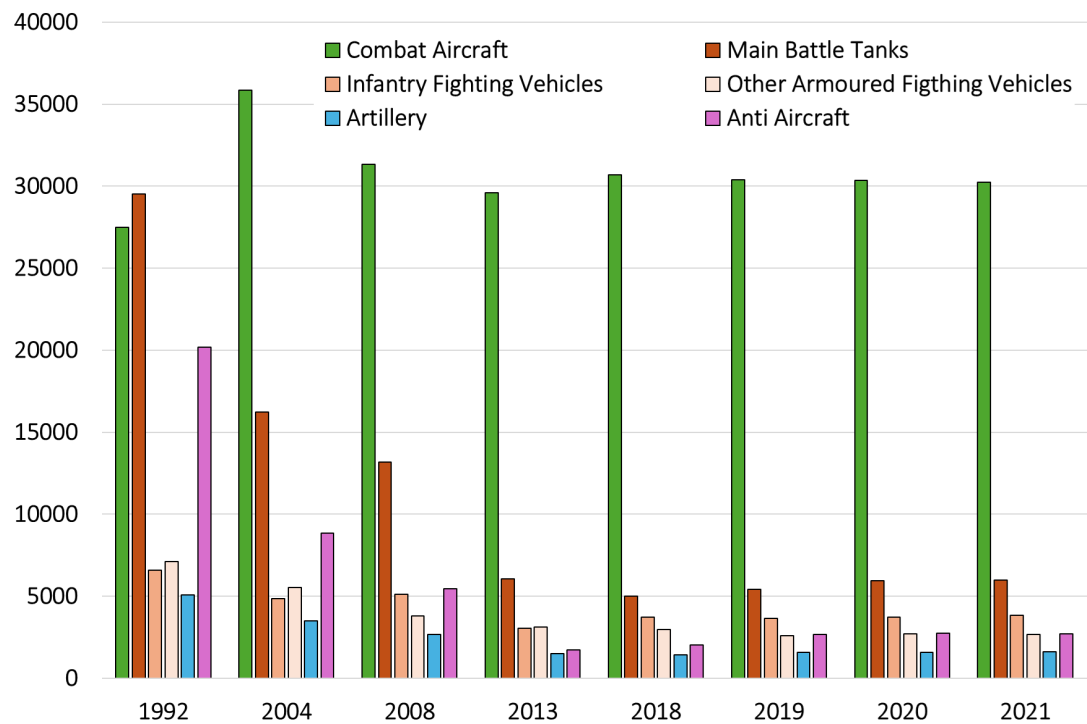
Note: This figure shows separate aggregate nominal production value for six categories of weapons: main battle tanks, infantry fighting vehicles, other armoured combat vehicles (excluding engineering vehicles), artillery (towed and self-propelled howitzers and MLRS), anti-aircraft weapons (towed and self-propelled missile systems and guns), and combat aircraft (fighters and non-strategic bombers). The production value is taken from SIPRI and is originally referred to as the Trend-Indicator Value (TIV).

Source: Own calculation, based on IISS Military Balance and SIPRI.

Figure A3.3 contains the evolution of the relative value of six categories from 2004 to 2021, calculated using the number of units from the IISS Military Balance publications and the trend indicator value from SIPRI. Comparing the total volume of each category in the four observed countries combined shows that the total volume of each category is decreasing over time, indicating declining military capabilities in the four selected countries, and thus an overall decline in European defence capacity.

Figure A3.3 also shows that in the decade following the end of the Cold War, European defence relied on combat aircraft, main battle tanks, and anti-aircraft systems, and less so on the other categories. This is consistent with the highly defensive doctrine NATO adopted during the Cold War. From 2000 on, a steep decline in all categories aside from combat aircraft can be observed. The decline is particularly notable for main battle tanks and anti-aircraft systems. This is consistent with the transition of European militaries in the early 2000s towards an expeditionary force model suitable for low-intensity interventions. Combat aircraft remain constant as they are key to NATO doctrine.

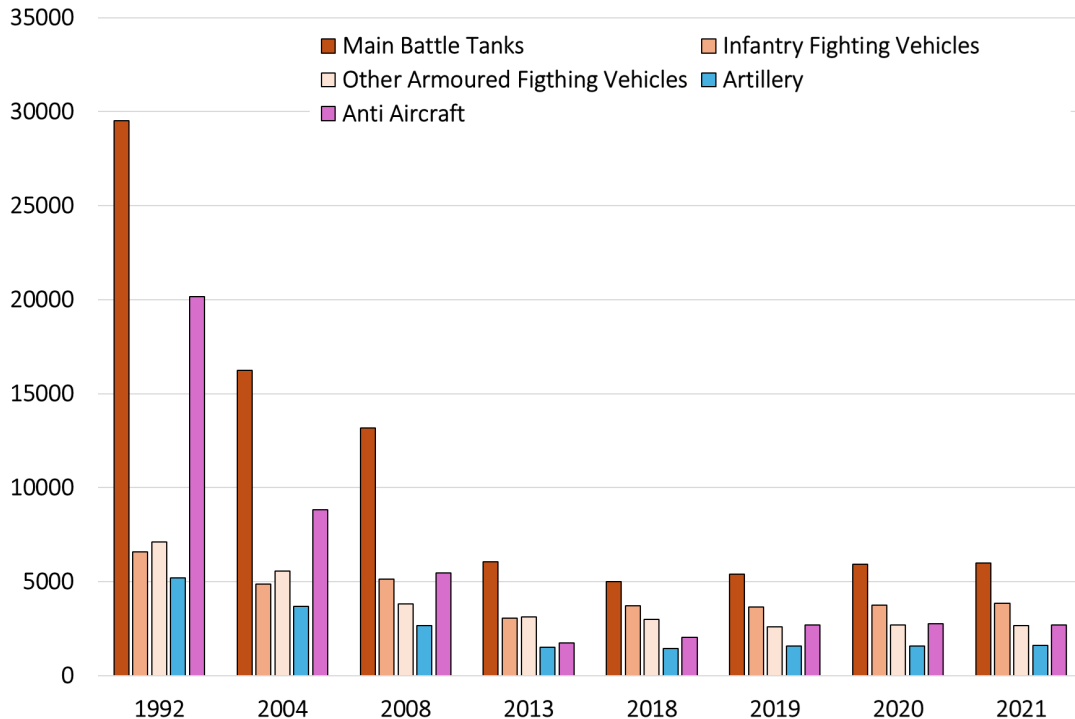
Figure A3.3:
Military capabilities of selected countries in six categories overtime (1992–2022)



Note: This figure shows separate aggregate nominal production value for combat aircraft (fighters and non-strategic bombers). The production value is taken from SIPRI and is originally referred to as the Trend-Indicator Value (TIV).

Source: Own calculation, based on IISS Military Balance and SIPRI.

Figure A3.4:
German, French, British, and Polish military capabilities for combat vehicles, artillery, and anti-aircraft weapons (1992–2021)

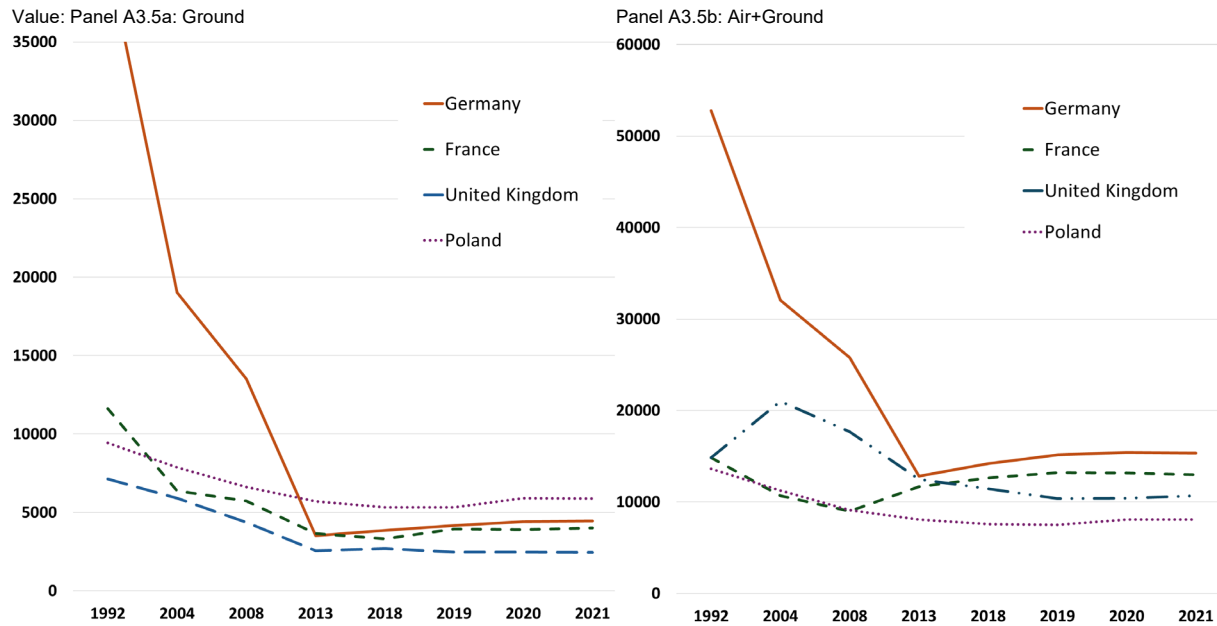


Note: This figure shows separate aggregate nominal production value for main battle tanks, infantry fighting vehicles, other armoured combat vehicles (excluding engineering vehicles), artillery (towed and self-propelled howitzers and MLRS), and anti-aircraft weapons (towed and self-propelled missile systems and guns). The production value is taken from SIPRI and is originally referred to as the Trend-Indicator Value (TIV).

Source: Own calculation, based on IISS Military Balance and SIPRI.

Figure A3.5 shows the evolution of the total relative values of all selected categories combined across countries. The figure confirms the dramatic decline in Germany's military power observed in the decline in the number of units in Section 3 of this report. It also confirms the decline for other countries. Thus, the decrease in the number of units has not been compensated by the increase in the quality of weapons.

Figure A3.5:
German, French, British, and Polish military capabilities in six categories, total (1992–2021)



Note: This figure shows total aggregate nominal production value for main battle tanks, infantry fighting vehicles, other armoured combat vehicles (excluding engineering vehicles), artillery (towed and self-propelled howitzers and MLRS), and anti-aircraft weapons (towed and self-propelled missile systems and guns) in Panel A, and for main battle tanks, infantry fighting vehicles, other armoured combat vehicles (excluding engineering vehicles), artillery (towed and self-propelled howitzers and MLRS), anti-aircraft weapons (towed and self-propelled missile systems and guns), and combat aircraft (fighters and non-strategic bombers) in Panel B. The production value is taken from SIPRI and is originally referred to as the Trend-Indicator Value (TIV).

Source: Own calculation, based on IISS Military Balance and SIPRI.

ANNEX A4

We construct the *Kiel Military Procurement Tracker* by methodically reviewing public government news sources found on the respective country's ministry of defence website. As such, information from government sources forms the basis of the database and carries the most weight and authority in case of discrepancies with other sources. We only include items mentioned as military orders or expenses by official government news and press release pages. Orders for which we have not found an official source are excluded completely. In cases where the government source omits important information pertaining to an order, unofficial news sources such as company websites that specifically refer to the order and contain missing details may be used to supplement the official source and fill out the database as much as possible. The sources used to construct each entry are found in the database.

The data collection period for Germany is January 2020 to July 2024.

Official websites for data collection:

Federal Ministry of Defense (Germany), "Alle Meldungen," <https://www.bmvg.de/de/aktuelles/alle-meldungen>.

Federal Ministry of Defense (Germany), "Alle Presstetermine und Pressemitteilungen aus dem BMVg," <https://www.bmvg.de/de/presse/alle-presstetermine-pressemitteilungen-bmvg>

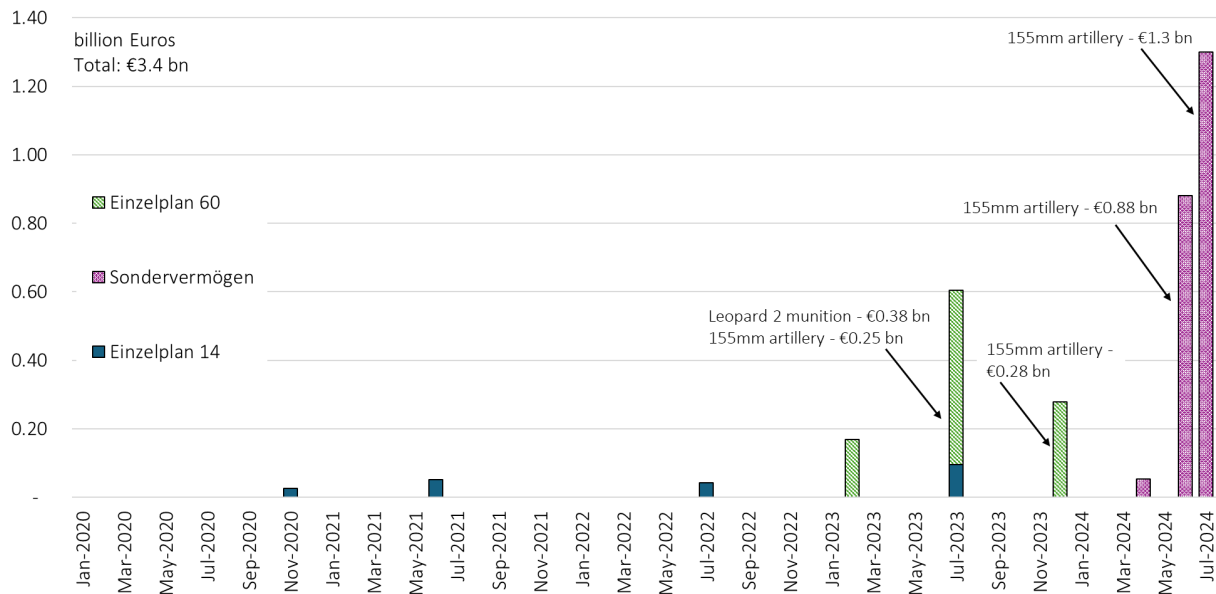
ANNEX A5

Figure A5.1:
Contract extensions and new military purchases, January 2020–July 2024 (billion Euros)



Source: Wolff, Kharitonov, Bushnell (2024).

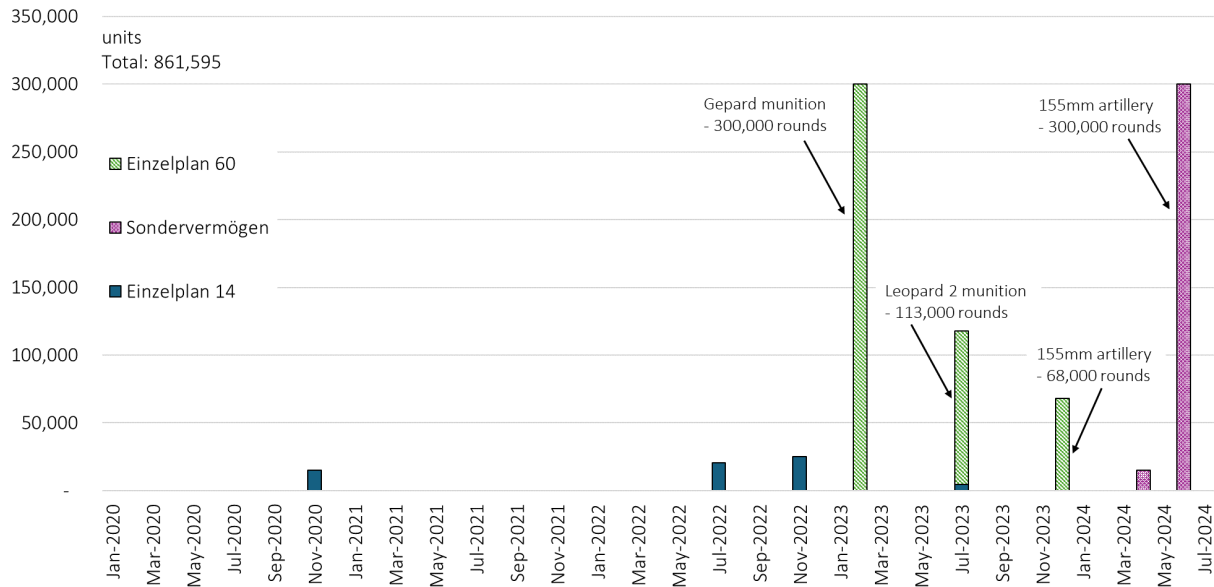
Figure A5.2:
Germany ammunition orders by month, January 2020–July 2024 (billion Euros)



Note: This figure excludes costs for ammunition development (€0.1 billion).

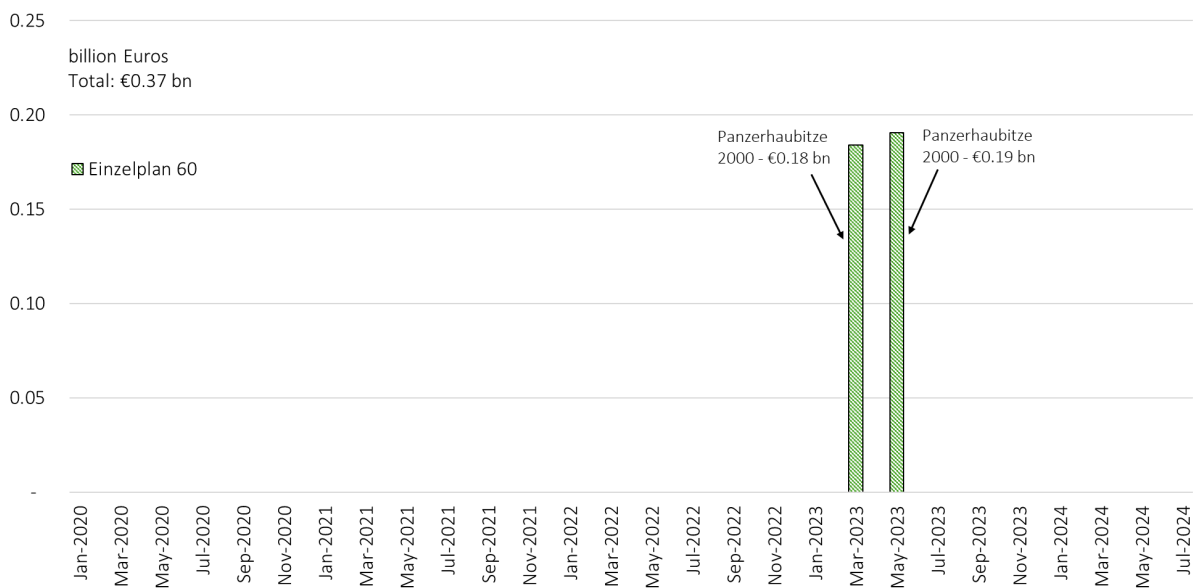
Source: Wolff, Kharitonov, Bushnell (2024).

Figure A5.3:
Germany ammunition orders by month, January 2020–July 2024 (units)



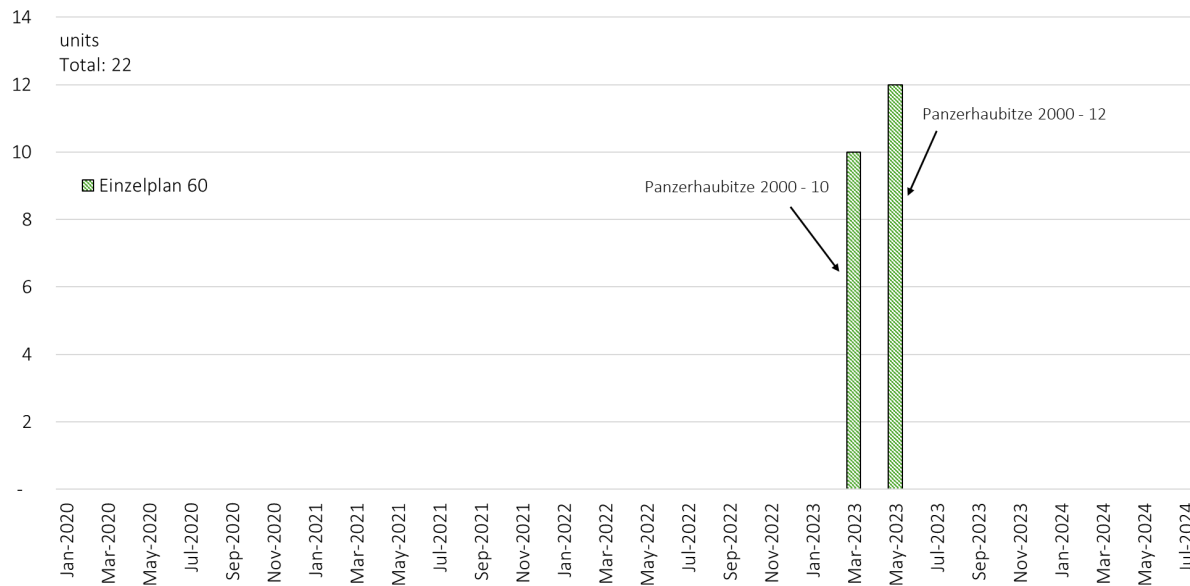
Source: Wolff, Kharitonov, Bushnell (2024).

Figure A5.4:
Germany howitzer orders by month, January 2020–July 2024 (billion EUR)



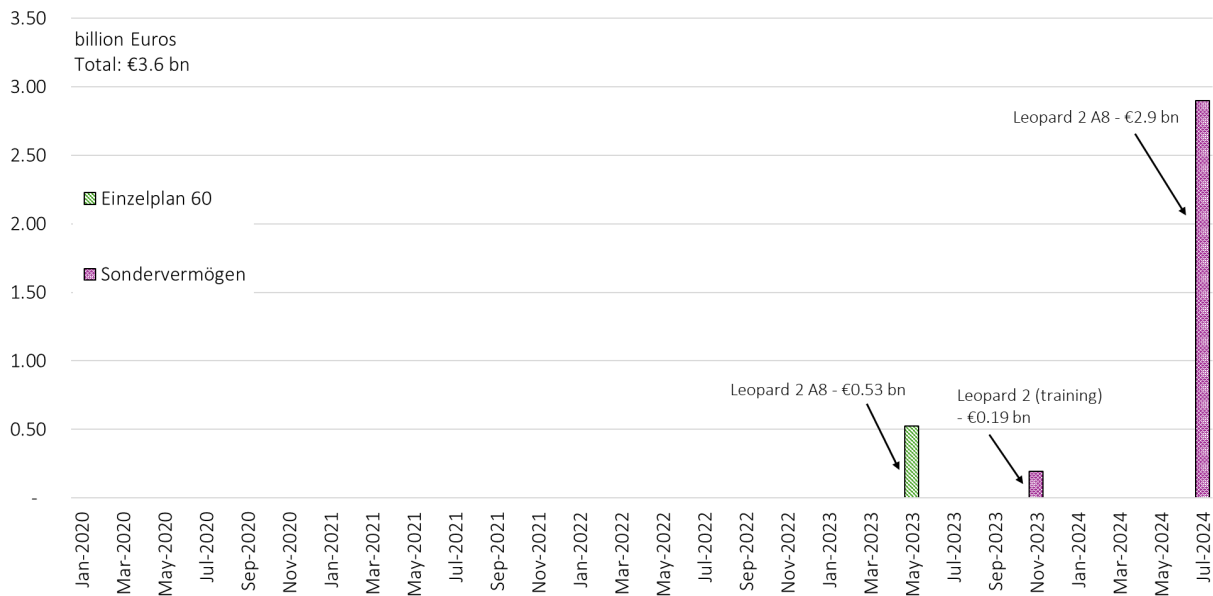
Source: Wolff, Kharitonov, Bushnell (2024).

Figure A5.5:
Germany howitzer orders by month, January 2020–July 2024 (units)



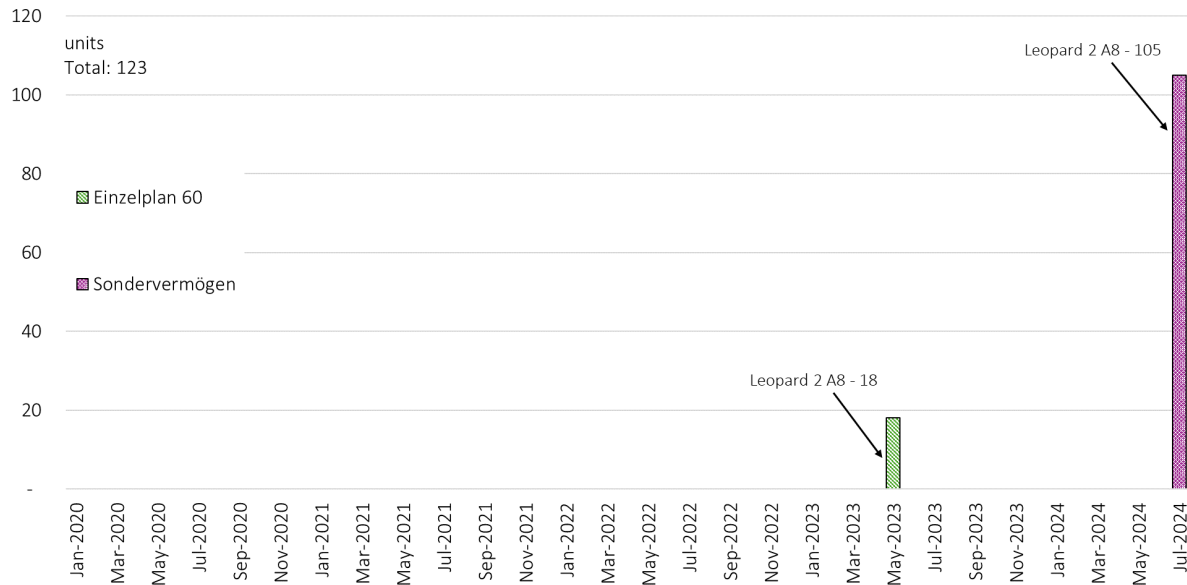
Source: Wolff, Kharitonov, Bushnell (2024).

Figure A5.6:
Germany main battle tank orders by month, January 2020–July 2024 (billion Euros)



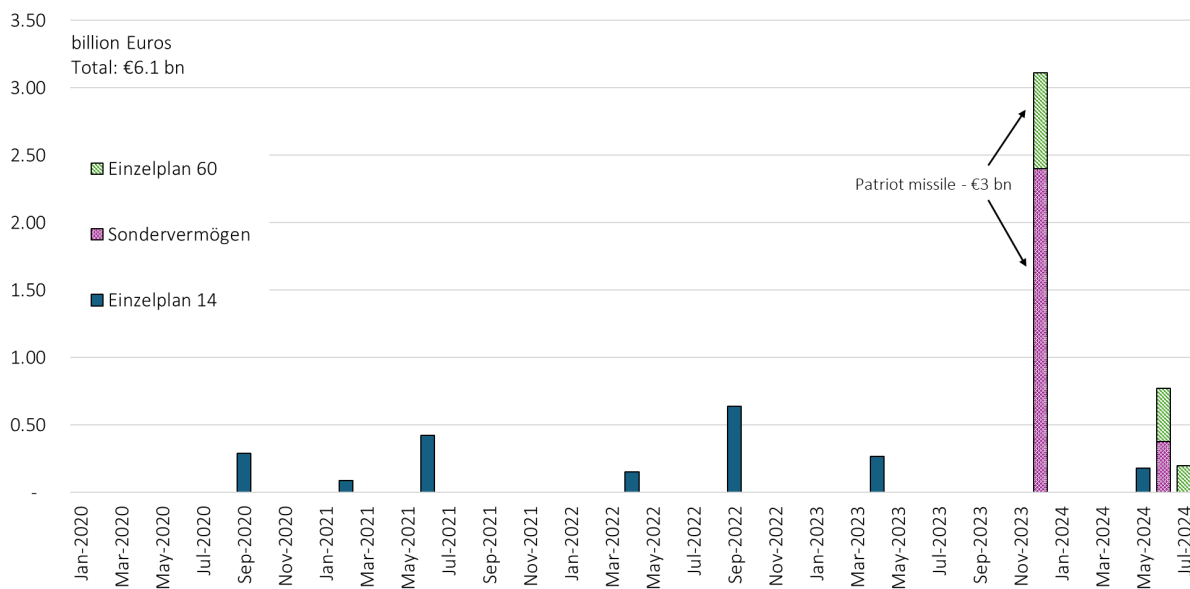
Source: Wolff, Kharitonov, Bushnell (2024).

Figure A5.7:
Germany main battle tank orders by month, January 2020–July 2024 (units)



Source: Wolff, Kharitonov, Bushnell (2024).

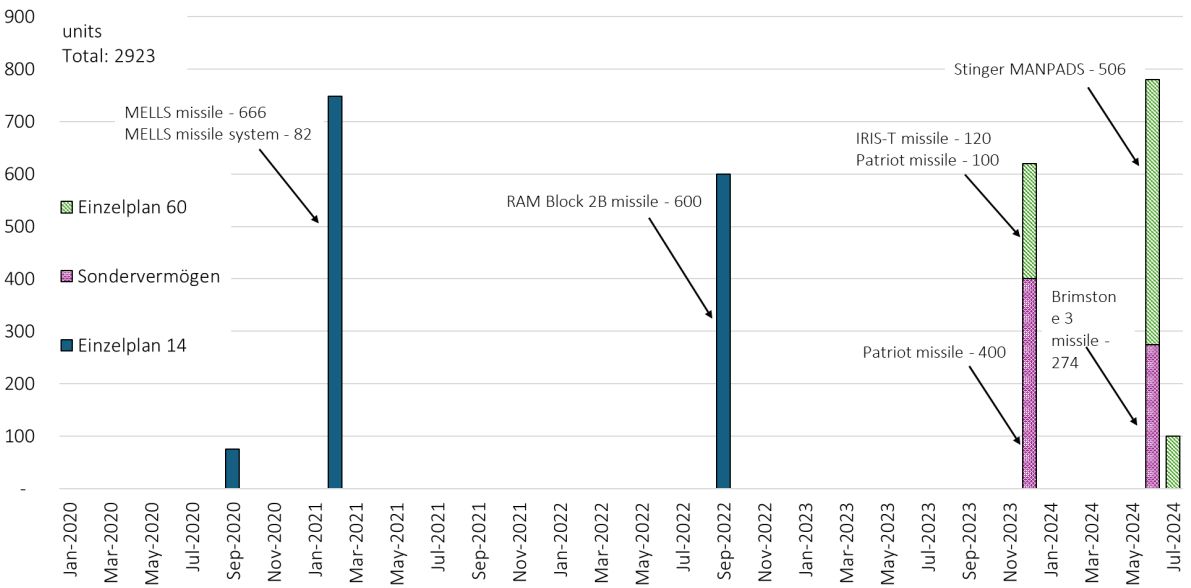
Figure A5.8:
Germany missile orders by month, January 2020–July 2024 (billion Euros)



Note: This figure excludes costs for missile development (€0.3 billion).

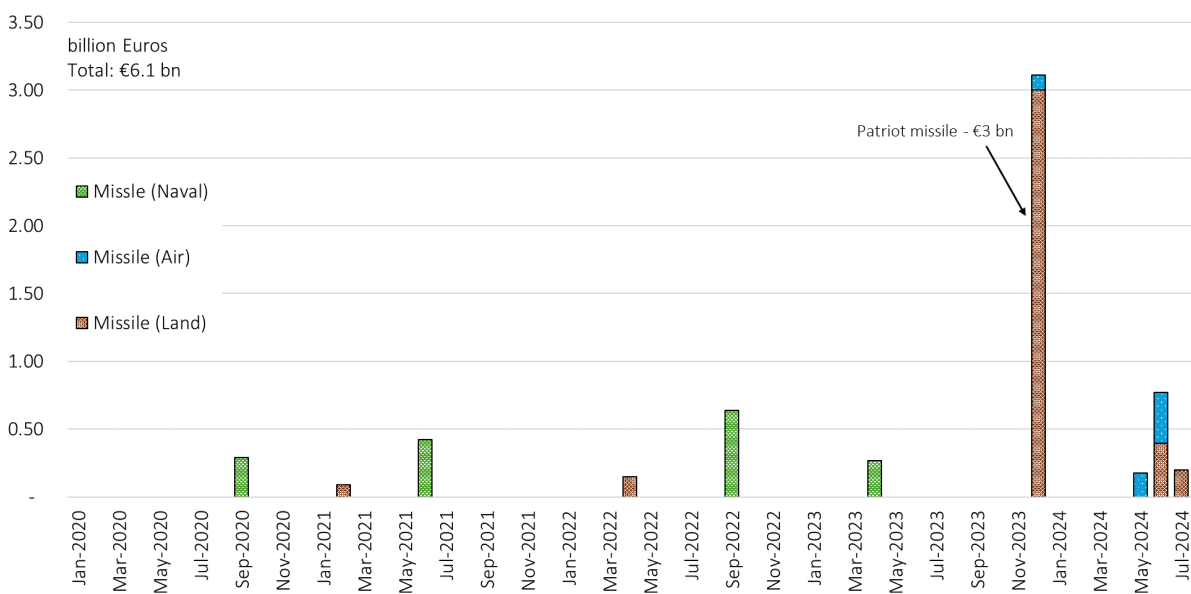
Source: Wolff, Kharitonov, Bushnell (2024).

Figure A5.9:
Germany missile orders by month, January 2020–July 2024 (units)



Source: Wolff, Kharitonov, Bushnell (2024).

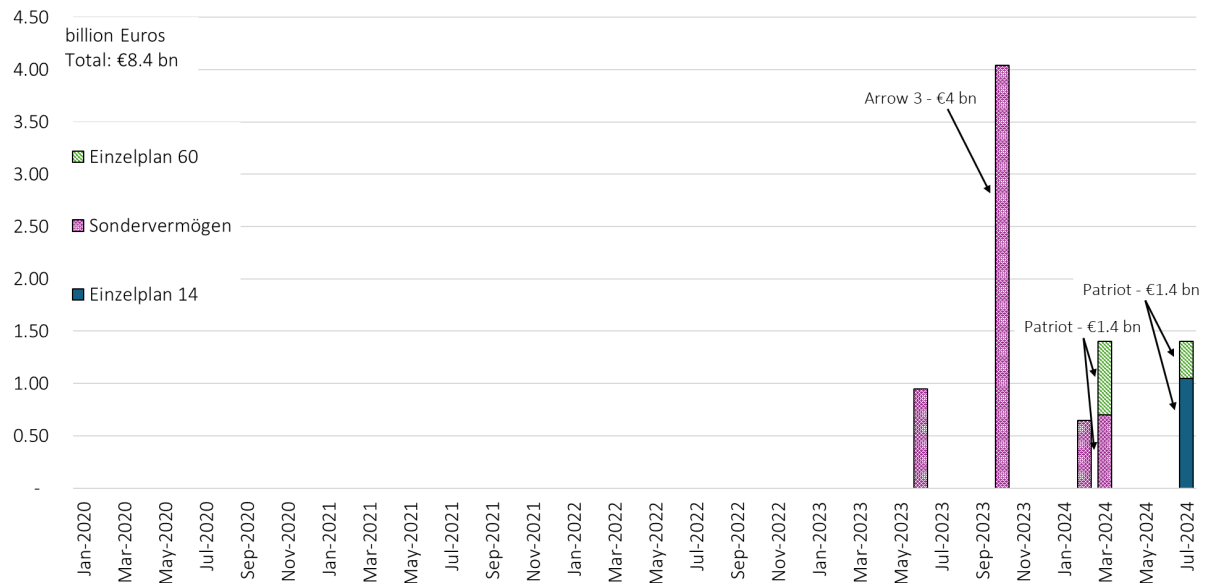
Figure A5.10:
Germany missile orders by category by month, January 2020–July 2024 (billion Euros)



Note: This figure excludes costs for missile development (€0.3 billion).

Source: Wolff, Kharitonov, Bushnell (2024).

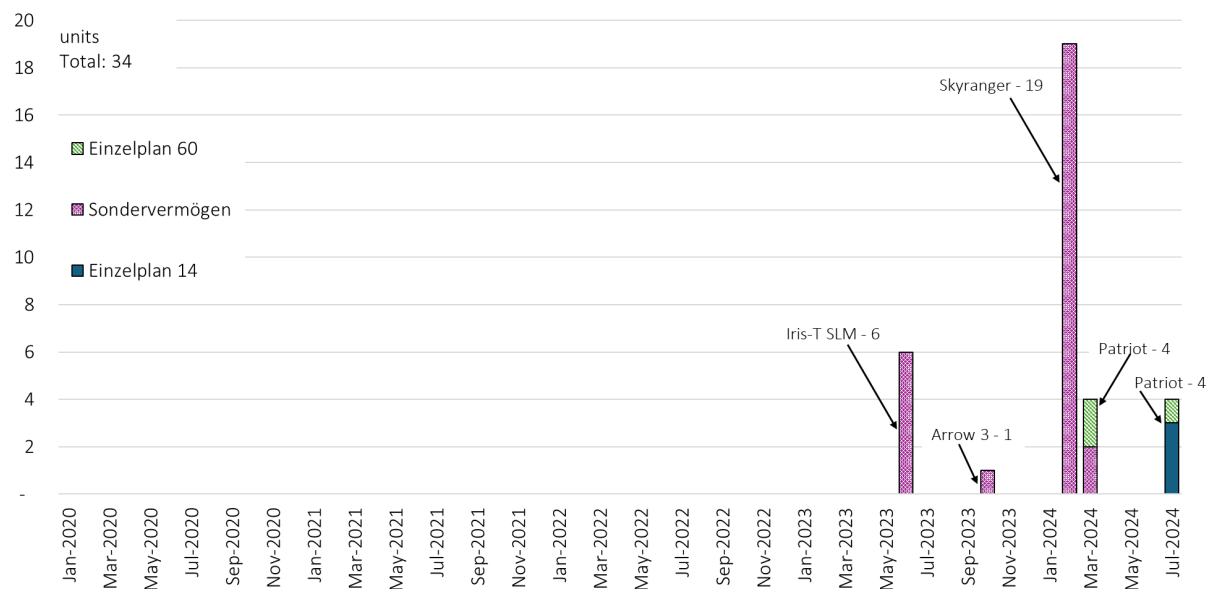
Figure A5.11:
Germany air defence system orders by month, January 2020–July 2024 (billion Euros)



Note: This figure excludes costs for air defence system development (€1.2 billion).

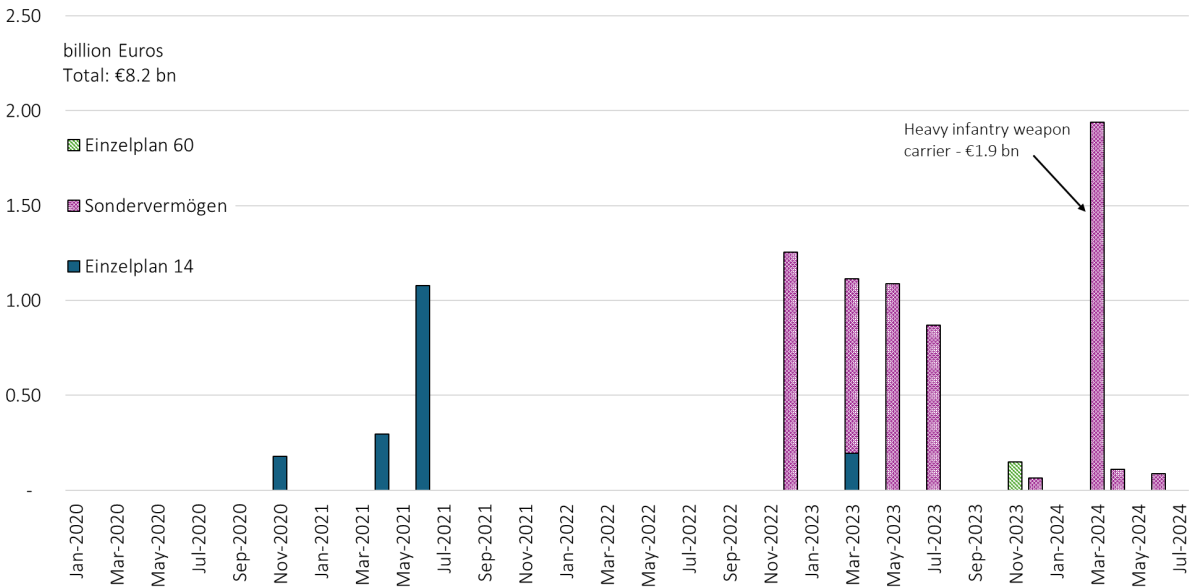
Source: Wolff, Kharitonov, Bushnell (2024).

Figure A5.12:
Germany air defence system orders by month, January 2020–July 2024 (units)



Source: Wolff, Kharitonov, Bushnell (2024).

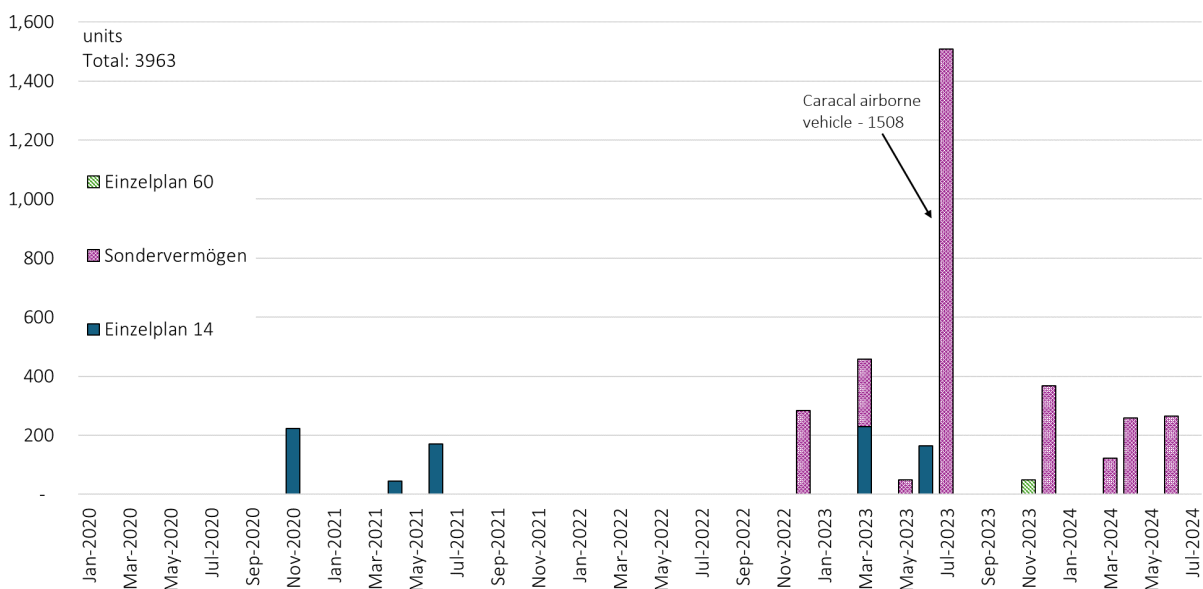
Figure A5.13:
Germany armoured vehicle orders by month, January 2020–July 2024 (billion Euros)



Note: This figure excludes costs for armoured vehicle development (€0.1 billion).

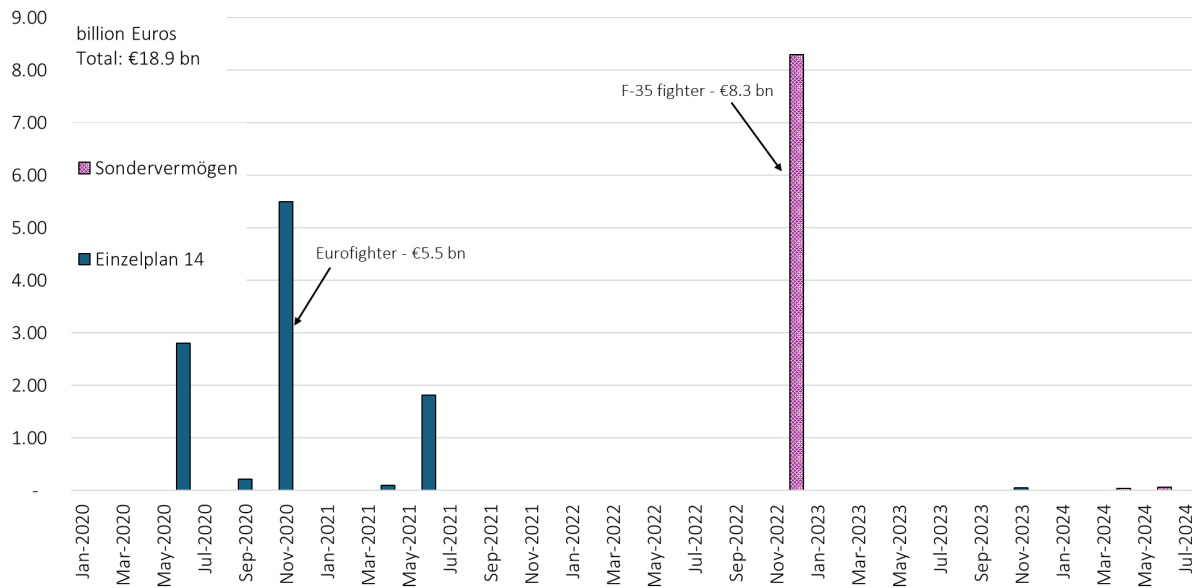
Source: Wolff, Kharitonov, Bushnell (2024).

Figure A5.14:
Germany armoured vehicle orders by month, January 2020–July 2024 (units)



Source: Wolff, Kharitonov, Bushnell (2024).

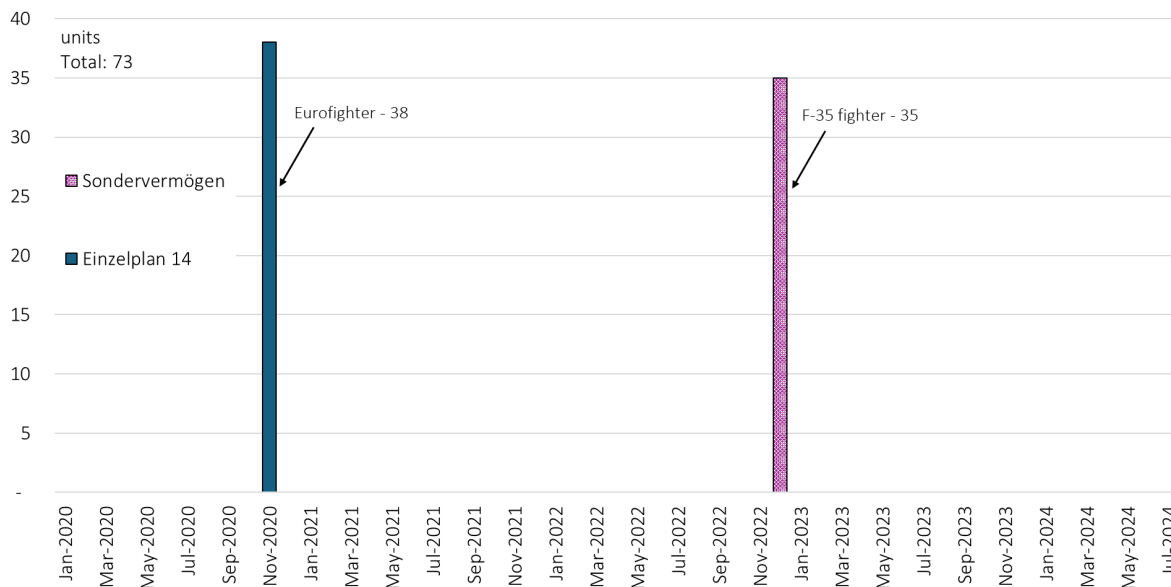
Figure A5.15:
Germany aircraft orders by month, January 2020–July 2024 (billion Euros)



Note: This figure excludes costs for aircraft development (€5 billion).

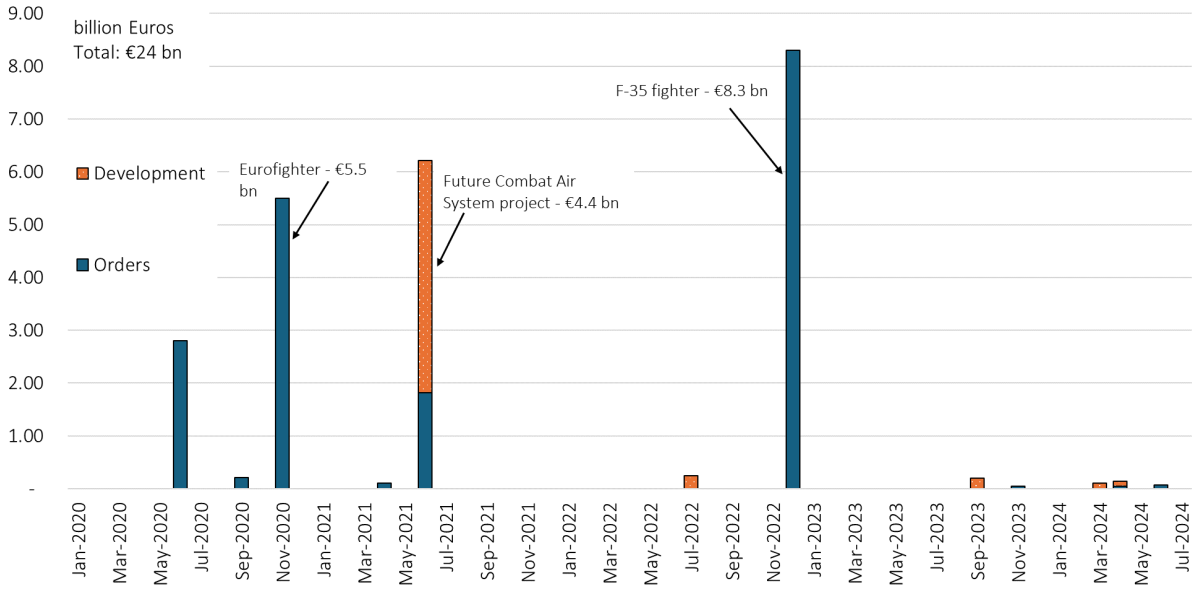
Source: Wolff, Kharitonov, Bushnell (2024).

Figure A5.16:
Germany fighter aircraft orders by month, January 2020–July 2024 (units)



Source: Wolff, Kharitonov, Bushnell (2024).

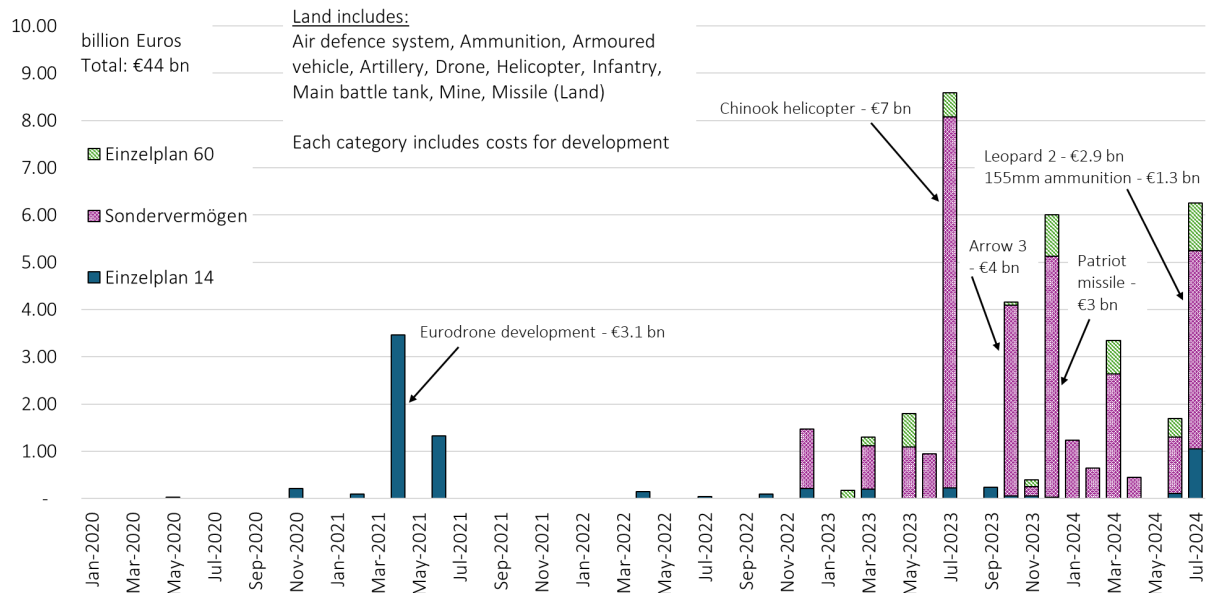
Figure A5.17:
Germany aircraft orders vs. development by month, January 2020–July 2024 (billion Euros)



Source: Wolff, Kharitonov, Bushnell (2024).

ANNEX A6

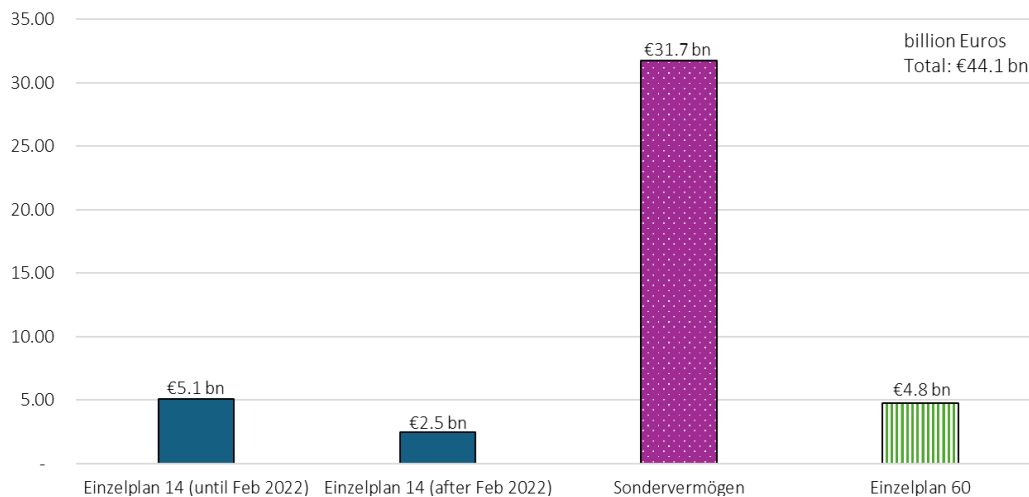
Figure A6.1:
Germany military orders for land forces by budgetary fund, January 2020–July 2024 (billion Euros)



Note: Around €12.1 billion worth of orders is attributed to both the Sondervermögen and regular defence budget, Einzelplan 14. In the absence of further details, we assume that these orders are funded by the Sondervermögen until the fund is exhausted and then any additional costs will be paid by the regular defence budget. In these cases, we attribute the value of the whole order to the Sondervermögen. Around €0.6 billion worth of orders is attributed to the Sondervermögen and Einzelplan 60. We count these orders as Einzelplan 60. Furthermore, in cases where the funding mechanism is not specified, we attribute the value of the order to the regular defence budget, Einzelplan 14.

Source: Wolff, Kharitonov, Bushnell (2024).

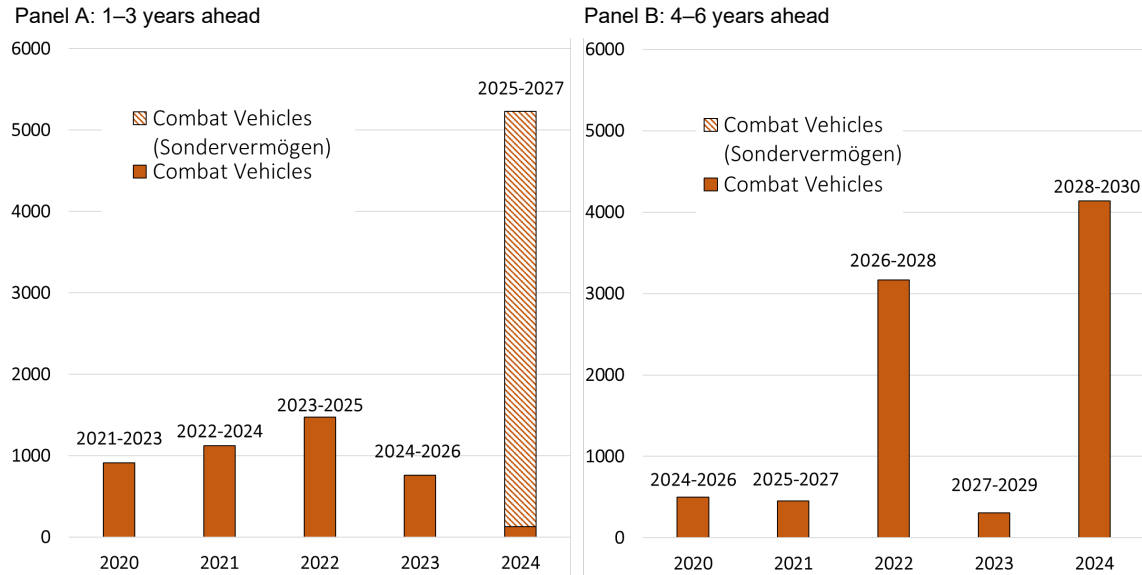
Figure A6.2:
Germany military orders for land forces by budgetary fund overview, January 2020–July 2024 (billion Euros)



Note: Around €12.1 billion worth of orders is attributed to both the Sondervermögen and regular defence budget, Einzelplan 14. In the absence of further details, we assume that these orders are funded by the Sondervermögen until the fund is exhausted and then any additional costs will be paid by the regular defence budget. In these cases, we attribute the value of the whole order to the Sondervermögen. Around €0.6 billion worth of orders is attributed to the Sondervermögen and Einzelplan 60. We count these orders as Einzelplan 60. Furthermore, in cases where the funding mechanism is not specified, we attribute the value of the order to the regular defence budget, Einzelplan 14.

Source: Wolff, Kharitonov, Bushnell (2024).

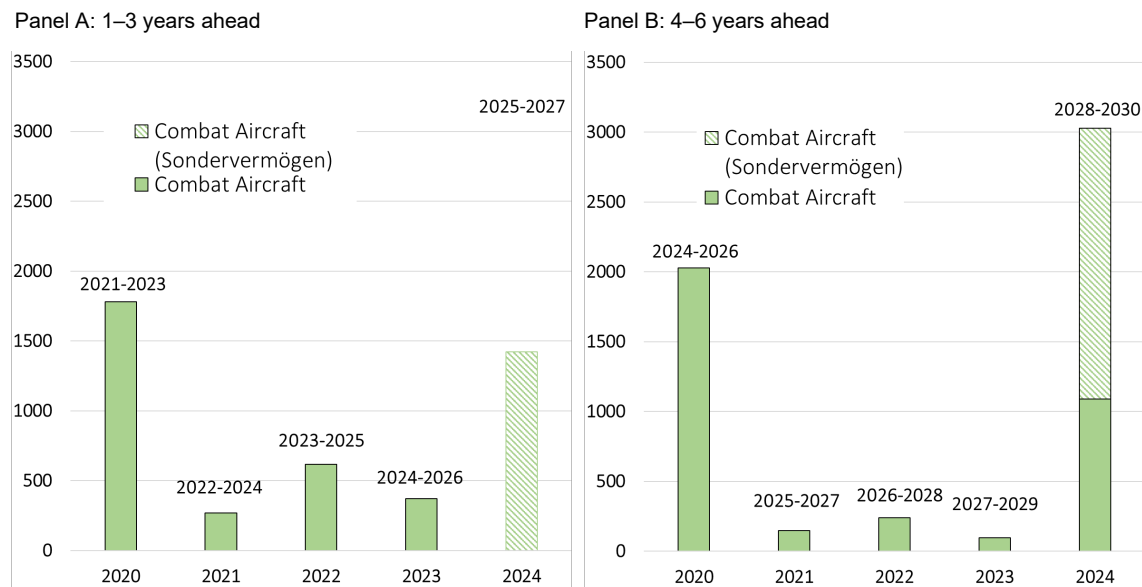
Figure A6.3:
Bundeswehr Combat Vehicle Procurement Budget, Commitment Appropriations in Section 14 (Einzelplan 14) and Special Fund (Sondervermögen) (million Euro)



Note: This figure shows total funds committed for spending in future fiscal years in budget years 2020–2024. Panel A shows funds committed for 1–3 years ahead and Panel B shows funds committed for 4–6 years ahead. The bottom of the chart shows the budget year in which the funds were committed, and the top of the bar shows the period for which those funds were committed.

Source: Bundeshaushaltsplan 2020–2024.

Figure A6.4:
Bundeswehr Combat Aircraft Procurement Budget, Commitment Appropriations in Section 14 (Einzelplan 14) and Special Fund (Sondervermögen) (million Euros)



Note: This figure shows total funds committed for spending in future fiscal years in budget years 2020–2024. Panel A shows funds committed for 1–3 years ahead and Panel B shows funds committed for 4–6 years ahead. The bottom of the chart shows the budget year in which the funds were committed, and the top of the bar shows the period for which those funds were committed.

Source: Bundeshaushaltsplan 2020–2024.

ANNEX A7

Table A7.1:
Germany ammunition orders, January 2020–July 2024

	% of total entries				
No. of entries, total	16	.			
No. of entries, "Expected delivery (from)"	9	0.56			
No. of entries, "Expected delivery (to)"	9	0.56			
No. of entries, Expected delivery from and to	6	0.38			
Item	Units	Amount (€)	Year of order	Expected delivery (from)	Expected delivery (to)
Artillery ammunition					
155mm artillery round	.	1,300,000,000	2024	2027	2031
155mm artillery round	300,000	880,000,000	2024	2025	.
155mm artillery round for Ukraine	68,000	278,000,000	2023	.	.
155mm artillery round DiNa for Ukraine	4,700	27,300,000	2023	.	2025
.	.	128,000,000	2023	.	.
155mm artillery round DM121 for Ukraine	.	.	2023	2023	2025
155mm artillery round DM121	.	.	2023	2023	.
	372,700	2,613,300,000			
Tank ammunition					
.	.	381,000,000	2023	.	.
120mm Leopard 2 ammunition	80,000	.	2023	.	2025
120mm Leopard 2 ammunition for Ukraine	33,000	.	2023	.	2025
30mm Puma ammunition	.	67,600,000	2023	.	.
30mm Puma ammunition	25,000	.	2022	2022	.
120mm Leopard 2 ammunition DM88 (training)	20,715	42,100,000	2022	2022	2022
120mm Leopard 2 ammunition DM88 (training)	15,000	26,000,000	2020	2020	2020
	173,715	516,700,000			
Gepard ammunition					
35mm Gepard ammunition for Ukraine	300,000	168,000,000	2023	2023	2023
	300,000	168,000,000			
Other ammunition					
Proximity fuse	.	.	2023	.	.
70mm Tiger attack helicopter rocket (training)	15,180	54,000,000	2024	2024	2026
Adjustable proximity fuse for 155mm artillery round	.	52,000,000	2021	.	.
	15,180	106,000,000			

SUMMARY		
	Units	Amount (€)
Artillery ammunition	372,700	2,613,300,000
Tank ammunition	173,715	516,700,000
Gepard ammunition	300,000	168,000,000
Other ammunition	15,180	106,000,000
Total ammunition	861,595	3,404,000,000

Note: Over the period January 2020–July 2024, Germany made 16 ammunition orders. Nine of them (56%) include an estimation of an earliest delivery date and nine of them (56%) include an estimation of a latest delivery date. However, only six ammunition orders (38%) include both an earliest and latest expected delivery date.

Source: Wolff, Kharitonov, Bushnell (2024).

Table A7.2:**Basic Germany ammunition framework agreements, January 2020–July 2024**

ID	Item	Total Amount (€)
DE_155mm_1	155mm artillery round DiNa	118,000,000
DE_155mm_2	155mm artillery round DM121	246,000,000
DE_155mm_3	155mm artillery round	8,500,000,000
DE_155mm_4	155mm artillery round	N/A
DE_120mm_1	Leopard 2 ammunition	4,000,000,000
DE_70mm_1	70mm attack helicopter rocket	N/A
DE_30mm_1	Puma ammunition	576,000,000
Total:		13,440,000,000

Note a: DE_155mm_3 includes Denmark, Estonia, and Netherlands as part of the contract.

Note b: DE_155mm_4 is part of the EU Ammunition Initiative.

Source: Wolff, Kharitonov, Bushnell (2024).**Table A7.3:****Extended Germany ammunition framework agreements, January 2020–July 2024**

ID	Item	Date	No. of Units	Amount (€)	Total amount (€)	Amount ordered (€)	Units ordered
DE_155mm_1	155mm artillery round DiNa	.	.	.	118,000,000	27,300,000	4,700
DE_155mm_1a	.	.	.	.	.	.	.
DE_155mm_1b	.	7/18/2023	350,000	118,000,000	.	.	.
DE_155mm_2	155mm artillery round DM121	.	.	.	246,000,000	128,000,000	N/A
DE_155mm_2a	.	.	.	137,000,000	.	.	.
DE_155mm_2b	.	7/18/2023	.	109,000,000	.	.	.
DE_155mm_3	155mm artillery round	.	.	.	8,500,000,000	2,180,000,000	300,000
DE_155mm_3a	.	7/18/2023	350,000	1,200,000,000	.	.	.
DE_155mm_3b	.	6/5/2024	.	7,300,000,000	.	.	.
DE_155mm_4	155mm artillery round	.	.	.	N/A	278,000,000	68,000
DE_155mm_4a	.	12/14/2023	350,000	.	.	.	.
DE_120mm_1	Leopard 2 ammunition	.	.	.	4,000,000,000	449,100,000	148,715
DE_120mm_1a	.	12/17/2020	203,000	556,000,000	.	.	.
DE_120mm_1b	.	7/13/2023	.	3,444,000,000	.	.	.
DE_70mm_1	70mm attack helicopter rocket	.	.	.	N/A	54,000,000	15,180
DE_70mm_1a	.	4/10/2024	31760	.	.	.	.
DE_30mm_1	Puma ammunition	.	.	.	576,000,000	67,600,000	25,000
DE_30mm_1a	.	12/8/2023	600,000	576,000,000	.	.	.
Total:		.	.	.	13,440,000,000	3,184,000,000	561,595

Note a: DE_155mm_3 includes Denmark, Estonia, and Netherlands as part of the contract.

Note b: The Kiel Military Procurement Tracker only captures the first two orders from the extension of the DE_155mm_3 agreement, worth €2.2 billion. Rheinmetall states that Germany made three additional orders from this framework agreement in October and December 2023 and procured at least 100,000 rounds. We do not include this information in the database because there is no record of these orders on the official BMVG websites. See: <https://www.rheinmetall.com/de/media/news-watch/news/2023/10/2023-10-06-abruf-ausrahmenvertrag-ueber-155mm-artilleriemunition> ; <https://www.rheinmetall.com/de/media/news-watch/news/2023/10/2023-10-10-dritter-abruf-artilleriemunition> ; <https://www.rheinmetall.com/de/media/news-watch/news/2023/12/2023-12-18-rheinmetall-abruf-rv-artillerie-155mm>

Note c: DE_155mm_4 is part of the EU Ammunition Initiative.

Source: Wolff, Kharitonov, Bushnell (2024).

REFERENCES

- Bardt, H. (2018). Deutsche Verteidigungsausgaben seit dem Ende des Kalten Krieges, *Wirtschaftsdienst*, 98(9), 680–682, available at <https://doi.org/10.1007/s10273-018-2351-2>.
- Bergmann, M., Snegovaya, M., Dolbaia, T., and Fenton, N. (2023). Seller's remorse: The challenges facing Russia's arms exports. CSIS, 18 September 2023, available at https://csis-website-prod.s3.amazonaws.com/s3fs-public/2023-09/230918_Bergmann_Seller%27s_Remorse.pdf?VersionId=NVJUT98MUcdL6omB.5ZM03zApNB4dUb.
- Boone, L., and Popescu, N. (2024). Europe must build a war economy without delay, *Le Monde*, April 1, 2024, available at https://www.lemonde.fr/en/opinion/article/2024/04/01/europe-must-adapt-and-build-a-war-economy-without-delay_6666993_23.html.
- Burgoon, B., Van Der Duin, D., and Nicoli, F. (2023). What would Europeans want a European defence union to look like?, Working Paper 09/2023, Bruegel, available at <https://www.bruegel.org/working-paper/what-would-europeans-want-european-defence-union-look>.
- Cancian, M.F. (2023). Rebuilding U.S. inventories: Six critical systems, CSIS, available at <https://www.csis.org/analysis/rebuilding-us-inventories-six-critical-systems>.
- Cavoli, C.G. (2024). *Statement of General Christopher G. Cavoli, United States Army, United States European Command*, available at https://armedservices.house.gov/sites/evo-subsites/republicans-armedservices.house.gov/files/USEUCOM%20GEN%20Cavoli%20CPS_HASC_2024.pdf.
- Choi, S. (2024). North Korea sent Russia millions of artillery shells, South Korea says, *Time*, 14 June 2024, available at <https://time.com/6988568/north-korea-russia-artillery-shell-south-korea-defense-minister/>.
- CIA (1982). *Transfer of Austrian gun-barrel forging technology to the USSR*, available at <https://www.cia.gov/read-ingroom/docs/TRANSFER%20OF%20AUSTRIAN%20GUN-%5B14686313%5D.pdf>.
- Dorn, F. (2024). Defence spending for Europe's security – How much is enough?, *Intereconomics: Review of European Economic Policy*, 59(4), available at <https://www.intereconomics.eu/contents/year/2024/number/4/article/defence-spending-for-europe-s-security-how-much-is-enough.html>.
- Dorn, F., Potrafke, N., and Schlepper, M. (2024). *European defence spending in 2024 and beyond: How to provide security in an economically challenging environment*, EconPol Policy Report, No. 45, CESifo GmbH, Munich, available at <https://hdl.handle.net/10419/289556>.
- Dupuy, T. (1995). *Attrition: Forecasting battle casualties and equipment losses in modern war*, Hero Books, Fairfax VA, USA.
- Epstein, J.M. (1988). Dynamic analysis and the conventional balance in Europe, *International Security*, 12(4), 154–165.
- European Commission (2024). *The Commission allocates €500 million to ramp up ammunition production, out of a total of €2 billion to strengthen EU's defence industry*, Press Release, March 15, 2024, available at https://ec.europa.eu/commission/presscorner/detail/en/ip_24_1495.
- European Commission and High Representative of the Union for Foreign Affairs and Security Policy (2024). A new European defence industrial strategy: Achieving EU readiness through a responsive and resilient European Defence Industry, *JOIN* (2024) 10 final, available at https://defence-industry-space.ec.europa.eu/edis-joint-communication_en.
- Federle, J., Meier, A., Müller, G., and Sehn, V. (2022). Proximity to war: The stock market response to the Russian invasion of Ukraine, CEPR Discussion Papers 17185, CEPR Discussion Papers, available at <https://ideas.repec.org/p/cpr/ceprdp/17185.html>.
- Fiott, D. (2024). The Challenges of defence spending in Europe, *Intereconomics: Review of European Economic Policy*, 59(4), available at <https://www.intereconomics.eu/contents/year/2024/number/4/article/the-challenges-of-defence-spending-in-europe.html>.
- French Ministry of Defense (2024). Industrial reinforcement: armaments and munitions, March 27, 2024, available at: <https://www.defense.gouv.fr/actualites/renforcement-industriel-armement-munitions>.

- French Ministry of Economics, Finance and Industrial and Digital Sovereignty (2024). State budget. Expenditure by ministry, available at https://www.budget.gouv.fr/budget-etat/ministere?annee=135&loi_finances=50&type_budget=all&ministere=62835&type_donnee_budget=ae&op=Valider.
- German Federal Foreign Office (2023). Robust. Resilient. Sustainable. The German national security strategy, 14 June 2023, available at <https://www.auswaertiges-amt.de/en/ausussenpolitik/themen/-/2601730>.
- German Ministry of Defense (2023). Defence policy guidelines 2023, available at <https://www.bmvg.de/resource/blob/5702190/edabed114d7856c8aa71ad666cbce8b3/download-defence-policy-guidelines-2023-data.pdf>.
- German Ministry for Economic Affairs and Climate Action (2023). *Bundeswehr besser ausrüsten – aber wie?*, Wissenschaftlicher Beirat im BMWK, available at https://www.bmwk.de/Redaktion/DE/Publikationen/Ministerium/Veroeffentlichung-Wissenschaftlicher-Beirat/bundeswehr-besser-ausruesten.pdf?__blob=publication-File&v=6.
- Graf, T.A. (2020). Unity in the face of threat? Exploring the empirical relationship between strategic threat perceptions and public support for a common European army in Germany, *European Security* 29(1): 55–73, available at <https://doi.org/10.1080/09662839.2019.1704267>.
- Hilgenstock, B., Ribakova, E., Vlasjuk, A., and Wolff, G.B. (2024). Using the financial system to enforce export controls, Working Paper 10/2024, Bruegel, available at <https://www.bruegel.org/working-paper/using-financial-system-enforce-export-controls>.
- Högl, E. (2024). *Annual report of the parliamentary commissioner for the armed forces*, Bundestag, available at https://www.bundestag.de/resource/blob/1007446/11eaf88ccacd47a774d424e01f8e6/annual_report_2023_65th_report.pdf.
- IISS (1992). *The Military Balance 1992*, available at <https://www.tandfonline.com/toc/tmib20/92/1>.
- IISS (2004). *The Military Balance 2004*, available at <https://www.tandfonline.com/toc/tmib20/104/1>.
- IISS (2014). *The Military Balance 2014*, available at <https://www.tandfonline.com/toc/tmib20/114/1>.
- IISS (2020). *The Military Balance 2020* available at <https://www.tandfonline.com/toc/tmib20/120/1>.
- IISS (2021). *The Military Balance 2021*, available at <https://www.taylorfrancis.com/books/9781003177777>.
- IISS (2022). *The Military Balance 2022*, available at <https://www.taylorfrancis.com/books/9781003294566>.
- IISS (2023). *The end of the US Air Force's ARRW hypersonic programme*, available at <https://www.iiss.org/en/online-analysis/missile-dialogue-initiative/2023/11/the-end-of-the-us-air-forces-arrw-hypersonic-programme/>.
- Ismar, G., and Schweikle, S. (2024). We must be prepared, *Süddeutsche Zeitung*, 7 July 2024, available at <https://www.sueddeutsche.de/politik/nato-bundeswehr-generalinspekteur-carsten-breuer-interview-russland-verteidigung-lux.RFCMdKwUPzXQRj8SkUMHoo?reduced=true>.
- Judson, J. (2024). *US to send Tomahawks, hypersonics, other long-range fires to Germany*, Defense News, 10 July 2024, available at <https://www.defensenews.com/land/2024/07/10/us-to-send-tomahawks-hypersonics-other-long-range-fires-to-germany/>.
- Laffont, J.-J., Tirole, J. (1986). Using cost observations to regulate firms, *Journal of Political Economy* 94, 614–641, available at <https://www.jstor.org/stable/1833051>.
- Lee, R. (2022). *The tank is not obsolete, and other observations about the future of combat*, war on the rocks, 6 September 2022, available at <https://warontherocks.com/2022/09/the-tank-is-not-obsolete-and-other-observations-about-the-future-of-combat/>.
- Letta, E. (2024). *Much more than a market – Speed, security, solidarity*, available at <https://www.consilium.europa.eu/media/ny3j24sm/much-more-than-a-market-report-by-enrico-letta.pdf>.
- Mejino-Lopez, J., and Wolff, G.B. (2024). What role do imports play in European defence, *Bruegel Analysis*, 4 July 2024, available at <https://www.bruegel.org/analysis/what-role-do-imports-play-european-defence>.
- Mérand, F., and Angers K. (2014). Military integration in Europe, in P. Genschel and M. Jachtenfuchs (eds), *Beyond the regulatory polity? The European Integration of Core State Powers*, Oxford University Press.
- Miller, C., Politi, J., and Schwartz, F. (2024). US to redirect Patriot air defence orders to Ukraine, *Financial Times*, 20 June 2024, available at <https://www.ft.com/content/89fe9d6b-3a0f-42a5-af50-cff7f457a126>.

- Mölling, C., and Schütz, T. (2023). Germany's defense budget 2024: The planned increase is not yet enough. *DGAP Memo*, 19 July 2023, available at <https://dgap.org/en/research/publications/germanys-defense-budget-2024>.
- Popescu, N. (2024). Need for speed: The case for a European defence production act, *ECFR*, 17 July 2024, available at <https://ecfr.eu/article/need-for-speed-the-case-for-a-european-defence-production-act/>.
- Prem, M. (2022). Tank construction: Entire industry threatened – Munich location also under pressure, *Merkur*, 16 February 2022, available at: <https://www.merkur.de/wirtschaft/muenchen-krauss-maffei-wegmann-bayern-panzer-wirtschaft-politikzr-91341614.html>.
- Pugnet, A. (2024). Where does the EU stand on its ammunition pledge to Ukraine?, *Euractiv*, April 17, available at: <https://www.euractiv.com/section/defence-and-security/news/where-does-the-eu-stand-on-its-ammunition-pledge-to-ukraine/>.
- Rácz, A., Spillner, O., and Wolff, G.B. (2023). *Russia's war economy*, DGAP Policy Brief No.3, available at <https://dgap.org/en/research/publications/russias-war-economy>.
- RAND (2017). Hypersonic missile nonproliferation: Hindering the spread of a new class of weapons, September 2017, available at https://www.rand.org/pubs/research_reports/RR2137.html.
- RAND (2024). Commission on the *national defence strategy*, July 2024, available at https://www.rand.org/content/dam/rand/pubs/misc/MSA3057-4/RAND_MSA3057-4.pdf.
- Röhl, K.H., Bardt H., Engels B. (2023). A new era for the defence industry? – Security policy an defence capability after the Russian invasion of Ukraine, Institut der Deutschen Wirtschaft Policy Paper, 1/2023, available at <https://www.iwkoeln.de/studien/klaus-heiner-roehl-hubertus-bardt-barbara-engels-a-new-era-for-the-defence-industry.html>.
- Ruitenbergh, R. (2024). Small drones will soon lose combat advantage, French Army chief says, *Defense News*, 19 June 2024, available at <https://www.defensenews.com/global/europe/2024/06/19/small-drones-will-soon-lose-combat-advantage-french-army-chief-says/>.
- Ruokkonen, A. (2024). Ukraine's artillery shell shortfall, *Lawfare*, 3 April 2024, available at <https://www.lawfare-media.org/article/ukraine-s-artillery-shell-shortfall>.
- Sauer, S. (2019). Joint arms projects: German-French secret paper reorganizes arms exports, *Der Spiegel*, 15 February 2019, available at <https://www.spiegel.de/politik/deutschland/ruestungsexporte-deutsch-franzoesisches-geheimpapier-a-1253393.html>.
- Seddon, M., and Cook, C. (2024) Russian navy trained to target sites inside Europe with nuclear-capable missiles, *Financial Times*, 13 August 2024, available at <https://www.ft.com/content/237e1e55-401d-4eeb-875b-03fe68f81575>.
- Steinbach, A., and Wolff G.B. (2024). Debt financing European air defence, *Intereconomics, Review of European Economic Policy* 59(4), available at <https://www.intereconomics.eu/contents/year/2024/number/4/article/debt-financing-european-air-defence.html>.
- Straub, C. (2022). Bundeswehr stands more or less bare, *Tagesspiegel*, 24.2.2022, available at <https://www.tagesspiegel.de/politik/bundeswehr-steht-mehr-oder-weniger-blank-da-5420455.html>.
- Streb, J., and Streb S. (1998) Optimale Beschaffungsverträge bei asymmetrischer Informationsverteilung: Zur Erklärung des nationalsozialistischen Rüstungswunders' während des Zweiten Weltkriegs, *Zeitschrift für Wirtschafts- und Sozialwissenschaften* 118, 275–294.
- Trebesch, C., Antezza, A., Bushnell, K., Bompreszi, P., Dyussimbinov, Y., Chambino, C., Ferrari, C., Frank, A., Frank, P., Franz, L., Gerland, C., Kharitonov, I., Kumar, B., Rebinskaya, E., Schade, C., Schramm, S., and Weiser, L. (2024). The Ukraine Support Tracker: Which countries help Ukraine and how?, Kiel Working Paper, No. 2218, 1–75, available at <https://www.ifw-kiel.de/topics/war-against-ukraine/ukraine-support-tracker/?cookieLevel=not-set>.
- Vershinin, A. (2024). The return of industrial warfare, *RUSI*, 17 June 2022, available at <https://www.rusi.org/explore-our-research/publications/commentary/return-industrial-warfare>.
- Watling, J., and Somerville, G. (2024). A methodology for degrading the arms of the Russian Federation, *RUSI*, 26 June 2024, available at <https://rusi.org/explore-our-research/publications/occasional-papers/methodology-degrading-arms-russian-federation>.

- Watling, J., and Dolzikova, D. (2024). Fighting for the light: Protecting Ukraine's energy system, RUSI, 12 August 2024, available at <https://rusi.org/explore-our-research/publications/commentary/fighting-light-protecting-ukraines-energy-system>.
- Wolff, G.B. (2024). European defence industrial strategy: Important but raising many questions, *Bruegel Analysis*, 19 March 2024, available at <https://www.bruegel.org/analysis/european-defence-industrial-strategy-important-raising-many-questions>.
- Wolff, G.B., Kharitonov, I., and Bushnell, K. (2024). *Kiel Military Procurement Tracker*, Kiel Institute. <https://www.ifw-kiel.de/publications/kiel-military-procurement-tracker-33232>

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