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Improving the quality of European defence spending

Cost of non-Europe report

STUDY

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Cost of non-Europe report

Building a European defence union is at the top of the EU's policy agenda. It is essential to preserving the security and wellbeing of EU society from current and future geopolitical threats. A reflection on the efficiency and quality of defence spending is a crucial first step in this process.

Based on research carried out for the European Parliamentary Research Service, this report investigates the potential gains from deeper European cooperation on defence spending that leverages the continent's economies of scale regarding: (i) military forces and strategic assets, (ii) defence equipment procurement, and (iii) research into emerging disruptive technologies.

The cost of non-Europe in defence spending is estimated to range from €18 to €57 billion per year. EU action to boost the efficiency and quality of European defence spending could also create jobs, improve the certainty of the business environment and boost the rule of law.

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Executive summary

In response to heightened geopolitical risks and security challenges, including Russia's war of aggression in Ukraine, European leaders have called for action to boost defence readiness.[1] In this context, the European Union institutions have put forward several initiatives and reports. The European defence industrial strategy presents a range of ambitious measures to support Member States move towards a European defence union.[2] The Letta Report calls for a 'radical transformation to build a common market for the security and defence industry'.[3] The Draghi Report presents ten proposals to improve the competitiveness of the European defence sector.[4] The Niinistö Report underscores that security is a public good and that readiness is a common responsibility.[5] A promising approach to respond to current and future challenges is deepening cooperation across Member States to leverage European economies of scale with regards to existing defence spending and activities, which are mainly organised at the national level.

What is the scope?

This 'cost of non-Europe' report investigates the quality of European defence spending and the extent to which deepening cooperation could leverage European economies of scale and boost efficiency, considering the nature of defence as a public good. It assesses the potential gains of scaling to the European level for different categories of defence spending. The research draws on an original quantitative analysis of publicly available data carried out by a research team from the Alexandru Ioan Cuza University based in Iași, Romania (see Annex I).

What are the key findings?

Table 1 presents the key findings for defence spending with respect to military forces and strategic assets, defence equipment procurement and defence research on emerging developing technologies. The cost of non-Europe in defence spending – in other words, the cost of not leveraging European economies of scale – is estimated to range from €18 to €57 billion per year.

European economies of scale can be leveraged by deeper cooperation between Member States for all defence activities, including at the planning stage. The more ambitious and deeper the cooperation in the EU, the greater the potential gains for all Member States. The EU could provide complementary executive capacity[6] and act further in the general interest of its citizens, thanks to the provision of financial incentives, facilitation and technical assistance. The EU could also reinforce the coordinated annual review on defence (CARD) process to broaden areas of common strategic interest especially for the 20-year horizon. Effort to improve the quality of European defence spending could promote higher standardisation and quality of European military equipment and generate other gains for society such as job creation, a more predictable environment for businesses and reinforced rule of law.

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1 European Council, Versailles Declaration, 10 and 11 March 2022.

2 European Commission, Joint Communication on a new European Defence Industrial Strategy: Achieving EU readiness through a responsive and resilient European Defence Industry. JOIN(2024)10 final, March 2024.

3 Enrico Letta, Much More than a Market – Empowering the Single Market to deliver a sustainable future and prosperity for all EU Citizens, April 2024.

4 Mario Draghi, The future of European competitiveness – Part B: In-depth analysis and recommendations, September 2024.

5 Sauli Niinistö, Safer Together – Strengthening Europe's Civilian and Military Preparedness and Readiness, October 2024.

6 Activities that support and supplement the capacities of Member States. For more, please see Christof Cesnovar et al., Mapping the cost of non-Europe report: Theoretical foundations and practical considerations, EPRS, European Parliament, October 2023.

Figure 1 – Summary of findings: Cost of non-Europe in defence spending

Summary of findings

	Military forces and strategic assets	Defence equipment procurement from EU countries	Defence equipment procurement from non-EU countries when an EU equivalent is not available	Research on emerging disruptive technologies
Key EU action	• Streamline decision-making processes in troop deployment. • Remove regulatory barriers and infrastructural bottlenecks in military mobility.	• Provide technical assistance to identify and address barriers to collaboration between Member States. • Provide financial incentives to widen collaboration with more Member States and to deepen collaboration to include the planning stage.	• Facilitate joint procurement of defence equipment of strategic EU interest from non-EU countries. • Promote development of defence equipment with like-minded countries that are of mutual strategic interest.	• Align defence innovation expertise across Member States with common European strategic priorities in the short, medium and long term (from 2040 and beyond). • Pool defence innovation spending to support a common European defence innovation agency similar to Defence Advanced Research Projects Agency in the US.
Cost of non-Europe				
Potential budgetary savings - low ambition scenario	**Up to €11.2 billion per year**	**Up to €3.2 billion per year**	**Up to €3.0 billion per year**	**Up to €820 million per year**
Potential budgetary savings - high ambition scenario	**Up to €45.3 billion per year**	**Up to €10.9 billion per year**		
Other potential gains	**Economic dimension:** a more competitive European defence industry thanks to greater scale and ability to take on larger projects and risk; more technological breakthroughs for defence and civilian applications; enhanced future defence capabilities; upward convergence in military capabilities across the EU. **Social dimension:** more defence industry jobs including high-tech jobs; higher returns on public spending; greater security of population; enhanced rule of law; improved security of business operating environment; increased mutual trust. **Environmental dimension:** longer lifespan of defence equipment due to enhanced interoperability and lower fragmentation.			

Source: EPRS

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1. Introduction

1.1. Defence in Europe

Building a European defence union is at the top of the EU's policy agenda.[7] Reforming it is central to achieving greater competitiveness, as the Draghi Report calls for,[8] and to ensuring Europeans' security and wellbeing.[9] Several factors lead to a new focus on the EU's role in defence and how to strengthen it:

- External threats to the EU, such as Russia's war of aggression in Ukraine pose serious risks to EU citizens' security. Conflicts, geopolitical rivalry, growing militarisation and hybrid threats are increasingly pressuring global security.[10] Preparedness for these shocks is a precondition to maintaining peace.[11]
- Defence is a public good,[12] an area where coordination at EU level could be beneficial for all and where net benefits of public spending at the European level are larger than those at the national level, through better use of resources and capabilities.
- European citizens are largely in favour of a common defence and security policy (CDSP). A 2023 Eurobarometer survey found that 8 out of 10 Europeans think cooperation in defence matters should be increased at EU level and believe that Member States' purchase of military equipment should be better coordinated. [13]

Commission President von der Leyen noted the following principle must be at the heart of EU action in defence – 'spend more, spend better, spend European'.[14] While Member States' defence spending has increased in recent years, it is fragmented and does not leverage European economies of scale. A 2020 EPRS study found that the efficiency of spending in the defence sector is low.[15] A reflection on the efficiency of European defence spending and how it can be improved is therefore a crucial first step in building a European defence union.[16] Such an approach could also support the shift in thinking about defence policy objectives – from achieving spending targets to achieving desired capabilities.

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7 Ursula von der Leyen, Europe's Choice – Political Guidelines for the Next European Commission 2024-2029. July 2024. See also Sebastian Clapp, Angelos Delivorias, Elena Lazarou and Marianne Pari, Financing the European defence industry, EPRS, European Parliament, September 2024.

8 Draghi.

9 As stated in the EU Charter of Fundamental Rights, the right to security is a fundamental right for every EU citizen.

10 The results of the 2024 Normandy Index, a tool developed by the European Parliament to map threats to peace and democracy worldwide, suggest the level of threats is the highest since the index began. See Elena Lazarou et al., Mapping threats to peace and democracy worldwide, EPRS, European Parliament, September 2024.

11 Sauli Niinistö, Safer Together – Strengthening Europe's Civilian and Military Preparedness and Readiness, October 2024.

12 A large number of studies move in this direction. See for example G. Felbermayr, A. Pekanov, Pan-European Public Goods: Rationale, Financing and Governance, Economic Governance and EMU Scrutiny Unit, European Parliament, 2024 or M. Buti and G. Papaconstantinou, European Public Goods: How can we supply more?, LEAP Policy Brief, Luiss, 2022.

13 Eurobarometer, European citizenship, Standard Eurobarometer 99 - Spring 2023, European Commission, June 2023.

14 See the 'Mission Letter' to Defence Commissioner-designate Andrius Kubilius, 17 September 2024.

15 Jérôme Saulnier, Improving the quality of public spending in Europe – Budgetary 'waste rates' in EU Member States, EPRS, European Parliament, October 2020.

16 As implied by the Draghi Report, other complementary actions could (2) boost private sector investment and (3) increase EU-level public spending on defence.

The European Commission conducted an impact assessment to support its proposal for the European defence industrial programme, but it was not supported by an analysis of defence spending.[17]

In recent years, the European Parliament has supported more cooperation, increased investment and pooling of resources to boost the defence sector at the EU level.[18] Already in the early 2000s, Members stressed the importance of rationalising defence efforts and increasing synergy between national and multinational projects. However, a turning point can be identified, with Russia's invasion of Crimea in 2014. Since then, the EU has launched a series of initiatives to deepen coordination between Member States, close capacity gaps and set ambitious goals and targets for procurement, cross-border research and development (R&D) collaboration and capacity building.

Challenges in EU defence policy are rooted in a highly complex scenario with political, budgetary and industrial dimensions. In particular:

1. The EU27 has a significant military capacity, but defence readiness is not optimal.
2. Defence equipment procurement is fragmented and inefficient, with inconsistent collaborative efforts across the EU. Moreover, Member States have limited bargaining power when acquiring defence equipment from non-EU countries.
3. Fragmentation in research innovation reduces the chances of breakthroughs with respect to emerging disruptive technologies that could support future defence capabilities.

This study investigates the potential gains of leveraging European economies of scale with respect to each of the three areas outlined above. It assesses the potential budgetary savings and other gains (e.g. social, environmental and fundamental rights) that could be possible. The study also highlights avenues for EU action to realise European economies of scale.

1.2. EU compared to China and the United States

Defence spending has been rising in recent years in many European countries. With Russia's invasion of Ukraine, many Member States have committed to meeting or exceeding the North Atlantic Treaty Organization (NATO) target of 2 % GDP spending on defence. However, the Member States' overall level of defence spending is about three times less than the US.[19] Nevertheless, the number of active soldiers is quite similar, at about 1.3 million each, but still below China's estimated 2 million soldiers (see Figure 2).

The European Commission's proposal on a European defence industrial programme, underlines that 'a responsive and competitive European defence technological and industrial base (EDTIB) is the foundation of any credible European role in its own defence and security'. Defence companies across Europe have experienced significant uncertainty regarding long-term demand, making them hesitant to expand production capacities significantly.[20] The size of the EU defence industry is still

[17] European Commission, Staff Working Document for a European defence industry programme and a framework of measures to ensure the timely availability and supply of defence products, accompanying the proposal for a regulation of the European Parliament and of the Council establishing the European defence industry programme and a framework of measures to ensure the timely availability and supply of defence products ('EDIP'), 8 July 2024.

[18] See for example: European Parliament resolution of 28 February 2024, 'Implementation of the common security and defence policy – annual report 2023' (2023/2119(INI)); European Parliament resolution of 11 December 2018 on military mobility (2018/2156(INI)); European Parliament resolution of 18 January 2023 on the implementation of the common security and defence policy – annual report 2022 (2022/2050(INI)).

[19] Stockholm International Peace Research Institute (SIPRI), Military Expenditure Database, September 2024.

[20] The International Institute for Strategic Studies (IISS), The Military Balance 2024, Routledge, February 2024. Previous editions of the same publication were used for comparison.

modest and arms production remains overwhelmingly located in certain Member States (e.g. France, Germany, Italy, Spain and Sweden.[21] Among the top 100 arms companies by revenue, 17 are European, including three trans-European firms. However, the combined revenue of EU companies, at €72 billion, lags behind their US and Chinese counterparts.[22]

The fragmentation of the defence landscape is confirmed by the different systems in use within the EU, as compared with the US, with a multiplication of efforts and missed opportunities to exploit economies of scale. For instance, it has been shown[23] that diverging operational requirements have led to the development of four different models of the Tiger helicopter, rather than one.

Spending on R&D is critical to developing future capabilities. Private R&D spending in the EU is lower than in the US, but not by as large a degree as overall defence spending. Public defence R&D spending however is notably higher in the US as compared with the EU – an estimated €71 billion, compared with €9.4 billion in the EU in 2022.[24] While data on public R&D spending in China is not considered reliable, sources suggest that it is high and has increased over time.[25]

[21] K L. Béraud-Sudreau and L. Scarazzato, Beyond Fragmentation? Mapping the European defence industry in an Era of Strategic Flux, Centre for Security, Diplomacy And Strategy, 2023.

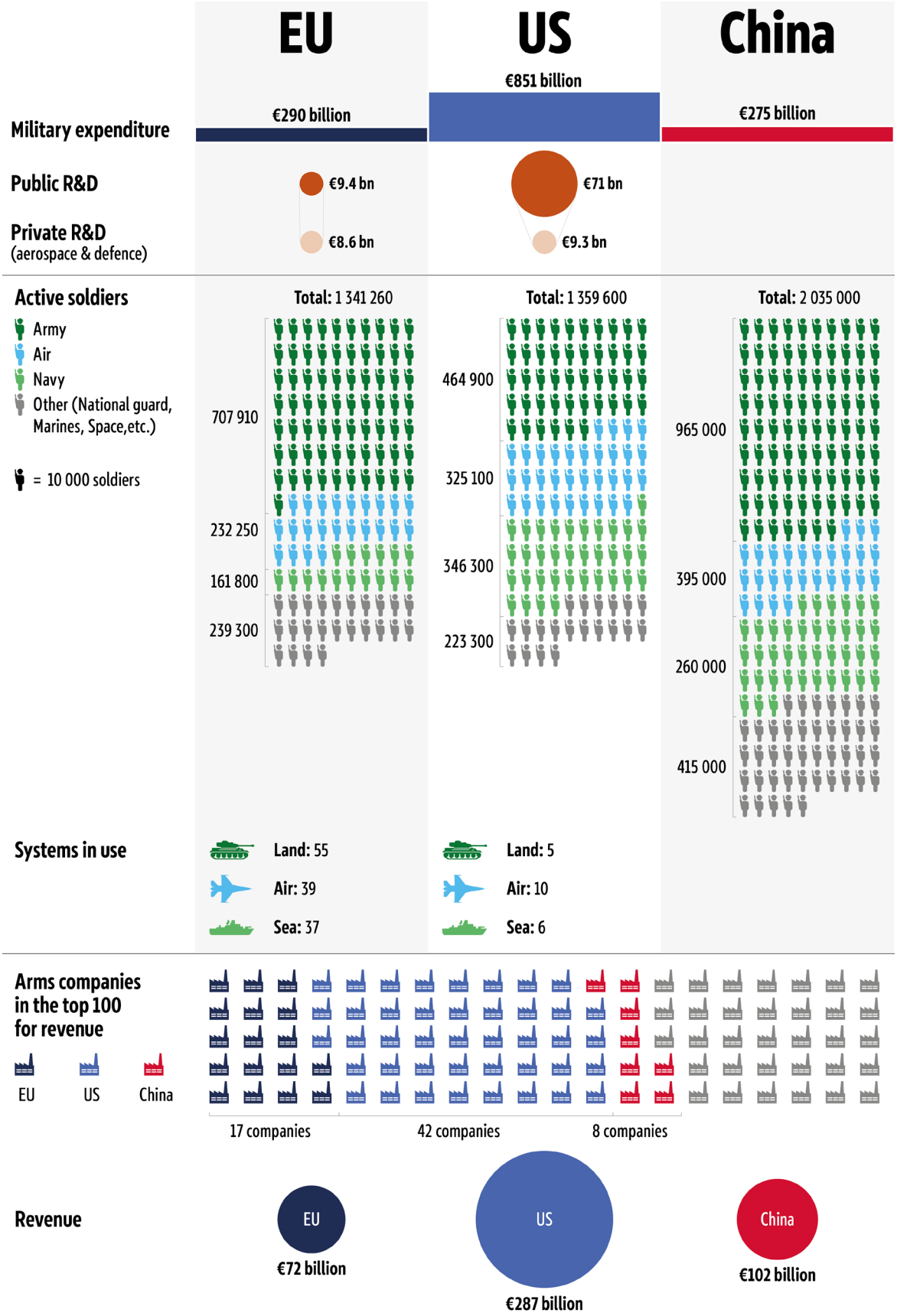
[22] X. Liang et al., The SIPRI Top 100 Arms-producing and Military Services Companies, SIPRI, 2023.

[23] M. Bergmann et al., Transforming European Defense, Center for Strategic and International Studies, 2022.

[24] L. Harris, Federal Research and Development (R&D), Funding: FY2024, Congressional Research Service, 2023 (Department of Defence) and European Defence Agency 2022 defence data.

[25] M. Nouwens and L. Béraud-Sudreau, Assessing Chinese defence spending: proposals for new methodologies, IISS, 2020. See also M. Taylor et al., 'Estimating China's Defense Spending: How to Get It Wrong (and Right)', *Texas National Security Review*, 2024.

Figure 2 – Comparison of defence sectors in the EU, US and China

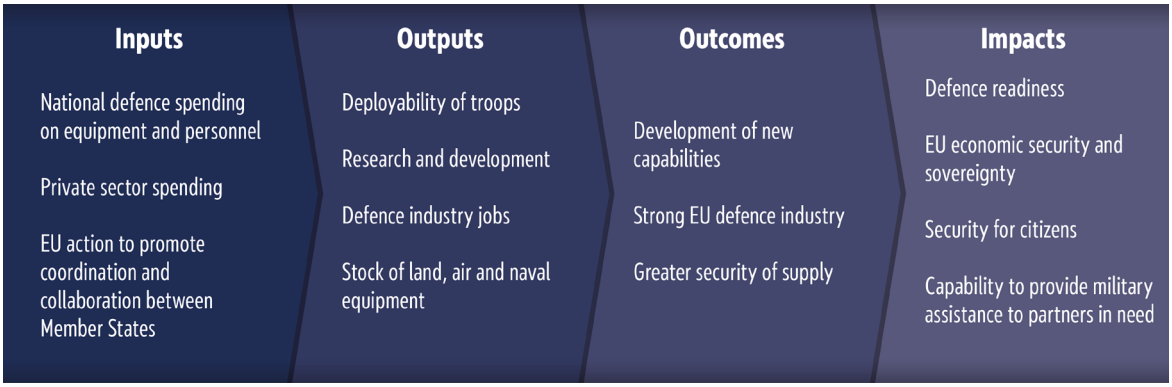


Source: Compiled by the author on the basis of the latest available data from the Stockholm International Peace Research Institute (SIPRI, 2024), the International Institute for Strategic Studies (IISS, 2024), the European Defence Agency (EDA, 2023), the Congressional Research Service (2023), JRC Scoreboard (European Commission, 2023) and Annex I.

2. Methodology

The study draws on an original, data-driven analysis of the inefficiencies in the European defence sector (see Annex I). Informed by the intervention logic in Figure 3 and Table 1 and using Member State-level data from public sources, the analysis investigates the translation of defence spending (inputs) to defence capabilities (outputs and outcomes), which supports the achievement of the overall, desired impacts.

Figure 3 – Defence sector intervention logic



Source: EPRS.

Table 1 – Description of defence sector intervention logic

	Examples
Inputs	The European defence sector is primarily financed by the public sector at the national level. EU Member States' defence spending reached €290 billion in 2023. Private sector spending in the defence sector is also crucial, but is limited by market barriers, complexity and the length of procedures.[26] The EU could do more to incentivise defence cooperation across Member States through increased financing and complementary executive capacity.
Outputs	Defence sector spending can influence the production of different outputs. For example, it could support the procurement of additional land, air and naval equipment in sufficient quantities. It could improve the deployability of troops, which is a direct indicator of a country's military operational capability. It could also boost R&D, generating new, including high-tech, jobs.
Outcomes	The outputs generated above could boost the main, desired outcome, which is a stronger EU defence industry. This would be driven in part by an upward convergence in military capabilities across the Member States, reduced supply-chain disruption, and timely identification of potential bottlenecks.
Impacts	The outcomes generated above could boost the main, desired impact, which is improved EU defence readiness. This would contribute to a greater sense of economic security as well as security for individuals. A stronger EU defence industry could support the 'right to engage in work' (Article 15 CFR) and the 'freedom to conduct a business' (Article 16 CFR). This is line with the EDIS, where is noted that 'the European defence industry is a crucial contributor to resilience, security, and social sustainability. There will be no economic prosperity without peace on the continent'. The assurance of security for individuals and businesses could promote the rule of law.

[26] European Commission, Access to equity financing for European defence SMEs, Directorate-General for Defence Industry and Space, Publications Office of the European Union, 2024.

The Data Envelopment Analysis (DEA) methodology was used to estimate the production frontier for European defence spending for certain outputs and outcomes related to defence readiness. The production function indicates the optimal level of output/outcome for a given level of defence spending. The difference between the actual level of output/outcome achieved by a Member State and the optimal level reflects the level of efficiency. The greater the distance between the actual and optimal levels, the greater the level of inefficiency.

The study assumes that deeper cooperation across Member States could reduce the level of inefficiency and shift defence readiness closer to the production frontier. The level of inefficiency that deepened European cooperation could address can be understood as the cost of non-Europe.[27] The analysis defines two scenarios for the cost of non-Europe. A low-ambition scenario assumes that the level of inefficiency in European defence spending is reduced to some extent. A high-ambition scenario assumes that European defence spending achieves efficiency.

Box 1 – What is 'deepened cooperation'?

Some Member States already cooperate to develop new defence equipment and conduct military exercises. For example, the Netherlands and Germany have procured the same type of battle tank and have an integrated tank battalion. The Netherlands and Belgium have a strong naval collaboration (known as Benesam).

Such bilateral cooperation agreements differ from cooperation on a European scale where all Member States can participate. Data reported to the European Defence Agency on 'European collaborative procurement' and 'European collaborative research and technology (R&T)' does not make a distinction.

Our study uses the European Defence Agency definitions, while coining a new term – 'deepened cooperation' – to refer to cooperation between all Member States and with respect to all aspects of defence planning. Deepened collaboration can leverage economies of scale at the EU-level. This study documents the potential gains (including budgetary savings) of such an approach.

Examples on cooperation from Dick Zandee, What are the main drivers of Member States' defence procurement practices?, Clingendael – Netherlands Institute of International Relations, 8 October 2024.

The analysis updates and extends a 2020 study[28] by focusing on four categories of European defence spending:

- Military forces and strategic assets;
- Defence equipment procurement within the EU;
- Defence equipment procurement from non-EU countries;
- Research on emerging disruptive technologies.

The analysis is limited to publicly available data and includes data from sources such as the European Defence Agency (EDA), North Atlantic Treaty Organization (NATO), Eurostat, the Stockholm International Peace Research Institute (SIPRI) and the International Institute for Strategic Studies (IISS).[29] Annual activity reports published by national Ministries of Finance and Defence were also taken into consideration. The analysis is limited by a lack of sufficiently detailed data, and a lack of homogeneity in the definitions of terms and different practices in reporting data, as has been reported in other EU defence analyses.[30]

27 Cesnovar et al.

28 Saulnier.

29 See Annex, Section 3.3.

30 As also reported in EDA Defence Data 2022, the agency currently faces challenges in conducting a meaningful analysis of defence indicators due to the limited data available, as only certain Member States provide data.

3. What challenges hinder the efficiency of European defence spending?

The analysis identified five challenges reflecting the lack of deep cooperation across Member States. Each is described below.

3.1 The EU has a large military capacity, but sub-optimal readiness

The combined number of active EU Member State soldiers exceeds 1.3 million, a similar figure to the US.[31] In most countries, the total number of soldiers is half what it was in 1990,[32] with several European armed forces currently unable to recruit and retain the people required.[33] Regardless of the total amount, only a small portion of Member States' forces is currently deployed (around 3 %),[34] with a range that varies.

Member States' armed forces remain largely organised and managed at the national level, although they regularly collaborate in multinational or international contingents.

Under the common security and defence policy (CSDP) framework, approximately 4 000 EU military personnel are deployed globally.[35] These military forces and civilian experts are detached by the EU's Member States under EU-led CSDP missions and operations. The common costs of these military operations are not funded by the EU budget, but covered by Member States through the European Peace Facility. These operations have remained limited in scope compared to the initiatives undertaken under NATO, the United Nations (UN) or by Member States in ad hoc coalitions. A single command centre for EU non-executive military CSDP Training Missions, the Military Planning and Conduct Capability (MPCC), was established in 2017 to strengthen coordination and cooperation on the ground. As defined by the Strategic Compass, by 2025, the MPCC should also be able to plan and conduct two small scale or one medium-scale executive operation(s), as well as live exercises. Analysts have underlined that, the MPCC is currently under-staffed and under-resourced to meet its mission. [36] [37]

Despite these initiatives,[38] personnel are trained and sustained by individual Member States. Defence is a national prerogative and remains in the hands of Member States. EU forces are controlled by 27 national command structures, supported by services that are strictly owned and managed by their own commands. Analysts have claimed that this national-level approach leads to inefficiencies in establishing, maintaining, and operating armed forces across Europe.[39]

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31 The International Institute for Strategic Studies (IISS), The Military Balance 2023, Routledge, February 2023.

32 M. V. Rasmussen, Rearmament with a Purpose, CESifo, Munich, 2024.

33 B. Giegerich et al., Building Defence Capacity in Europe: An Assessment, The International Institute for Strategic Studies, 2024.

34 Authors' calculation based on EDA, NATO and Ministries of Defence data.

35 As of 2024, 24 CSDP missions and operations are ongoing across Europe, Africa, and Asia, of which 10 are military and one is civilian-military. See EEAS, Missions and Operations, Strategic Communication, January 2023.

36 Y. Reykers and J. Adriaensen, 'The politics of understaffing international organisations: the EU Military Planning and Conduct Capability (MPCC) ', *European Security*, 2022.

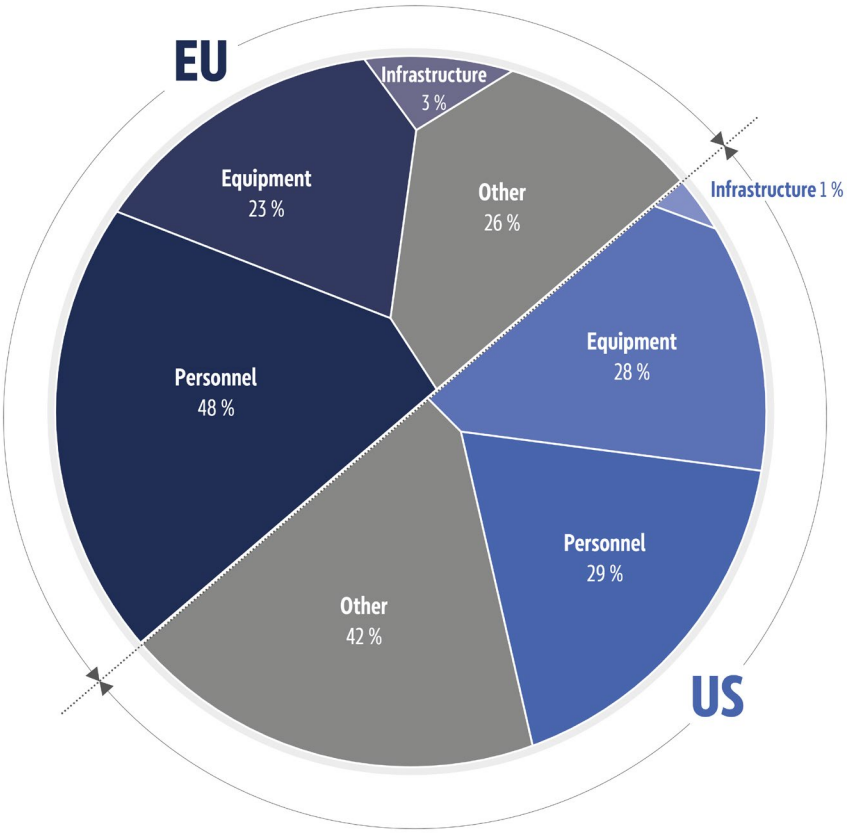
37 D. Fiott, L. Simón, EU defence after Versailles: An agenda for the future, Policy Department for External Relations, European Parliament, 2023.

38 See EDA. NATO also conducts training programmes for its multinational forces.

39 V. Briani, The Costs of Non-Europe in the Defence Field, Istituto Affari Internazionali, 2013.

In terms of expenditure, personnel costs account for nearly half of the resources allocated to defence budgets by Member States on average (48 %),[40] while the US stands at 29 % (see Figure 4). A larger portion of the Member States' budget is allocated to personnel remuneration rather than to operations, maintenance, infrastructure, equipment, and facilities. Some analysts[41] have claimed that under fiscal pressure, countries have often prioritised defence spending with immediate domestic benefits to the expense of other defence areas with less immediate impact, such as equipment. A relatively high level of spending on personnel as compared with spending on equipment could imply inefficiencies that also have higher-level consequences. This could imply that even when equipment is available, troops may not be adequately ready to act.

Figure 4 – Composition of defence spending: EU versus US



Source: EPRS based on latest data available from NATO and EDA.

The EU's emphasis on military mobility, a key component in optimising military readiness, has grown steadily in recent years. However, legislation is a source of continuing barriers to military transport in Europe. In many places, transportation infrastructure is underdeveloped[42] and unsuitable for transporting military personnel and equipment. Moreover, the need for diplomatic permission for armed forces to cross Member States still affects swift movements in peacetime.[43]

40 Figures from NATO 2024. For non-NATO members, EDA.

41 J. Becker, The correlates of transatlantic burden sharing: revising the agenda for theoretical and policy analysis, Defence & Security Analysis, 2017.

42 See Chapter 4 of L. Panella, Increasing European added value in an age of global challenges – Mapping the cost of non-Europe (2022-2032), EPRS, European Parliament, February 2023.

43 Niinistö.

Finally, as underlined by the Letta Report,[44] 'the use of civil and commercial space infrastructures for defence purposes is now a fact'. Space has become a key enabler for security and defence and one of the strategic domains of the Strategic Compass. So far, the Union relies on a range of space assets, such as IRIS, Copernicus, and Galileo. Yet, research shows that EU assets, agencies and bodies (e.g. EUSPA, EU SatCen) are not centralised in a coherent way.[45] This creates potential inefficiencies in countering and anticipating threats and affects the readiness of military forces.

3.2 Defence equipment procurement spending is fragmented and inefficient

Overall, about 20 % of national defence spending was allocated to the procurement of military equipment in 2022.[46] The level of defence equipment procurement and its sourcing is determined in large part by individual Member States' specific needs and objectives, rather than the EU as a whole. Based on an analysis of publicly available data concerning defence procurement orders between 2005 and 2023, this research finds a high level of variation in the type of military equipment procured by Member States as well as their sourcing. The data suggest that at the EU level, about 29 % of defence equipment spending was domestic, 33 % of spending was on equipment from other EU Member States and the remaining 37 % from other countries (see Figure 5). These percentages are likely to be different to figures cited elsewhere,[47] due to the differences in the timeframe and whether orders or deliveries were considered.

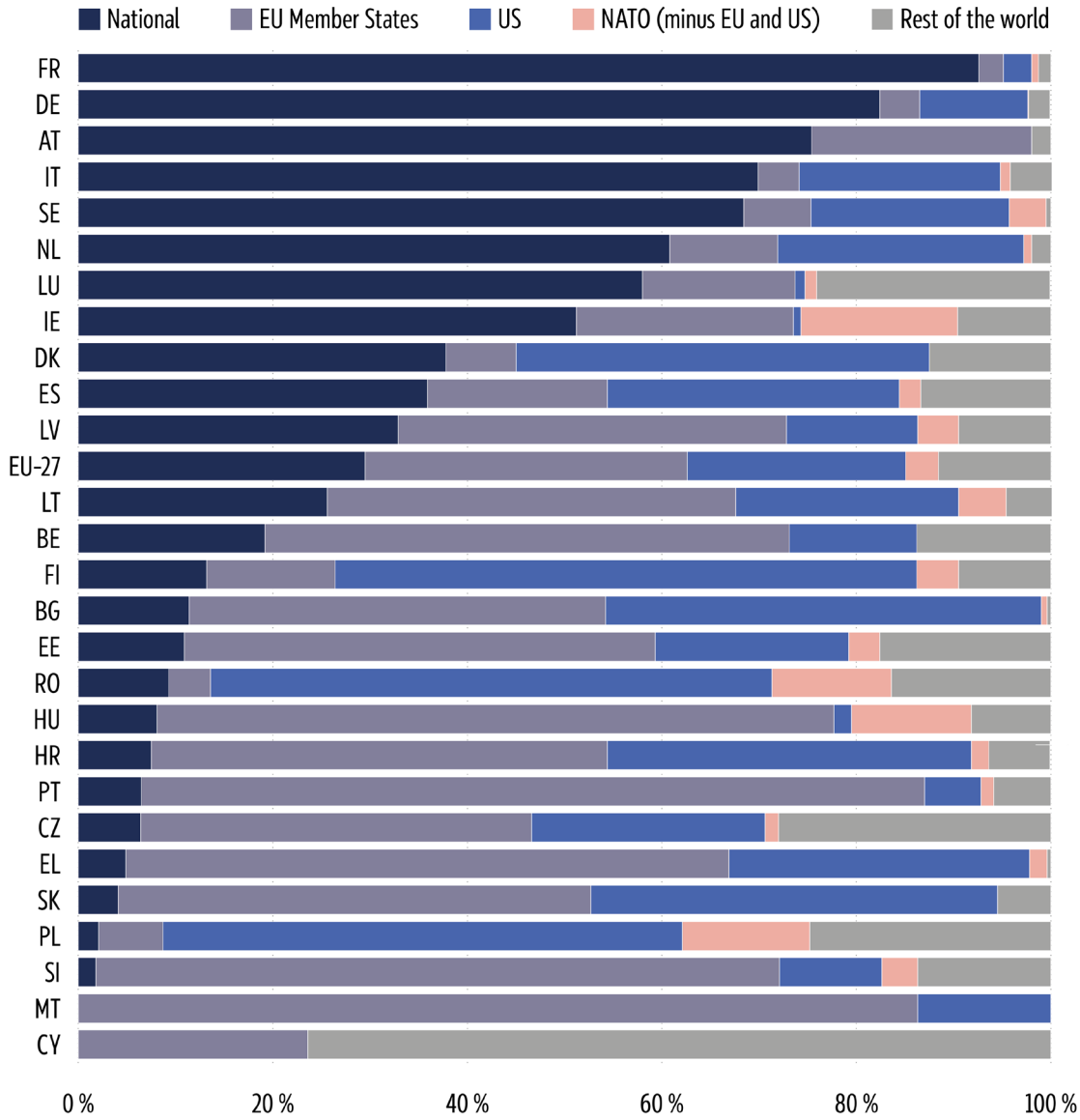
44 Letta.

45 D. Fiott, Strategic Domains: Developing the EU's Capabilities and Enablers for a Free and Secure Global Order, CSDS Policy Brief, July 2024.

46 European Defence Agency Defence Data 2022, downloaded 10 September 2024.

47 J. Maulny, The Impact of the War in Ukraine on the European Defence Market, Institut de Relations Internationales et Strategiques (IRIS), September 2023. Based on this study, both the EDIS and the Letta Report mention that 78 % of defence acquisitions from the start of the Russian war of aggression in Ukraine and June 2023 were made from outside the EU with the US alone accounting for 63 %. Another study from Bruegel reported that procurement from non-EU countries from 2021 to 2024 stands at less than 50 %. See J.M. Lopez, What role do imports play in European defence?, Bruegel, 2024. The IISS estimates this amount to be at least 48 %. See B. Schreer, Europe's defence procurement since 2022: a reassessment, IISS, 2024.

Figure 5 – Sourcing of defence equipment by EU Member States



Source: Annex I, Figure 12, 2005-2022. The different categories in this figure are mutually exclusive. This means that, for example, 'EU Member States' includes all the other 26 Member States and does not include the host country.

The lack of a harmonised approach across Member States implies an efficiency loss reflected in:

- The multiplication of different equipment and systems with limited interoperability. As noted in an earlier EPRS study, up to 17 different types of main battle tanks are in operation in the EU, compared to just one type in the US.[48]
- Different prices paid by Member States for the same equipment or system. For example, the estimated unit price of an armoured howitzer (PzH-2000) produced by Germany has varied more than five-fold, from €4.5 million to €23.5 million.[49] While differences in the specifications of the contracts (e.g. inclusion of spare parts and

[48] Lauro Panella et al., Ten ways that Europe could do more for you - Mapping the cost of non-Europe, EPRS, European Parliament, February 2024.

[49] See Annex I, Section 5.3.

training) could account for some of the variation, some inefficiencies could be avoided with deepened coordination. The analysis finds that the more the number of units ordered, the lower the unit price.

The efficiency of spending on defence equipment can be analysed in terms of future production of higher quality military equipment. Using the level of R&D spending as a proxy for the quality of future military equipment, the quantitative analysis finds that the fragmentation of national defence equipment spending in the EU generated inefficiencies of around €10.9 billion per year.[50] Phrased differently, national governments lost and continue to lose an estimated 44 cents for every euro invested in defence equipment due to the lack of an integrated, European approach.[51] The level of inefficiency is estimated to be highest for naval weaponry, followed by aircraft weaponry and land weaponry.[52] The aggregate inefficiency of €10.9 billion could be equivalent to:

- The purchase of more than 109 Eurofighter combat aircraft assuming a price tag of €100 million each;[53]
- The purchase of more than 390 Leopard 2 A8 battle tanks assuming a price tag of €28 million each;[54]
- 20 % of the gap towards meeting the 2 % NATO target;[55] or
- More than 20 % of the amount of additional annual defence investment called for by the European Commission.[56]

This inefficiency in defence equipment procurement also has consequences for employment in the sector. The quantitative analysis suggests that the level of inefficiency could be equivalent to more than 270 000 additional jobs in the defence industry.[57]

Defence spending has increased substantially in some Member States following Russia's invasion of Ukraine. In six Member States where defence spending increased by more than 10 % between 2021 and 2022, the estimated efficiency increased in two Member States.[58] [59] Analysis of defence

[50] See Annex I, Section 4.2.

[51] Annex I, Table 6, the overall efficiency score for Model 2 is 0.558. The waste is the difference between the efficiency score and the score of full efficiency, which is 1.

[52] Annex I, Table 9. The overall efficiency scores for land, aircraft and naval weaponry were respectively estimated to be 0.642, 0.590, and 0.329. The waste is the difference between the efficiency score and the score of full efficiency, which is 1.

[53] This assumption is based on S. Sprenger, Germany leans into Eurofighter with new order of 20 jets, *Defence News*, 5 June 2024.

[54] This assumption is based on S. Siebold, Germany to order 105 Leopard tanks to equip German brigade in Lithuania, Reuters, 20 June 2024.

[55] Draghi, page 160: 'If all EU Member States who are members of NATO who have not yet reached the 2 % target would do so in 2024 this would translate into approximately an additional €60 billion in defence spending'.

[56] Opening remarks by European Commission President following the meeting of the European Council of 27 June 2024 noted that €500 billion needed in defence investments over the next decade.

[57] The EDIS notes that the EDTIB employed about 500 000 people. Annex I, Section 4.2, Table 8 presents findings from a model relating defence equipment procurement spending and employment. The lower bound estimate of 0.553 was used for the calculation (0.553 * 500 000 = 276 500).

[58] The EDA 2022 report notes: Sweden (30.1 %), Luxembourg (27.9 %), Lithuania (27.6 %), Spain (19.3 %), Belgium (14.8 %) and Greece (13.3 %) recorded the highest increases in overall expenditure. Efficiency increased in Sweden and Luxembourg. The efficiency scores of defence spending by Member State can be found in Table 3 of Annex I.

[59] Other sources have suggested that non-aligned increases in spending could lead to more fragmentation, for example: N. Marsh et al., 'European defense spending: Trade-offs and consequences of non-alignment', *EconPol Forum*, ISSN 2752-1184, CESifo GmbH, Munich, Vol. 25(4), pp. 20-23.

spending over a longer time period (2014 to 2022) does not find a correlation between level of spending and the level of efficiency.[60]

The analysis finds EU spending efficiency would be equivalent to the United States if the EU's 27 different defence procurement systems were consolidated into one system.[61]

3.3 Collaboration among Member States on defence equipment procurement is uneven

The European Defence Agency collects data on 'European collaborative defence procurement', which measures the extent to which Member States are 'investing together'.[62] As noted in Box 1 in Section 2, this measure can reflect a wide variation in collaborative practices. Moreover, collaboration could also extend to joint planning on what to buy and how.[63]

Deepened cooperation on defence procurement between two or more Member States has the potential to promote greater harmonisation and interoperability in European defence equipment and systems. Deepened cooperation across Member States also has potential to generate budgetary savings due to economies of scale.

However, collaborative defence equipment procurement in the EU is uneven. The European Defence Agency reports that about 18 % of spending on the procurement defence equipment was collaborative between European countries in 2022.[64] As shown in Figure 5, the level of defence equipment spending and the share spent in a collaborative manner varies significantly across Member States. Collaborative procurement is not reported or absent in about half of the EU Member States. This may be due to a range of barriers, such as:

- Clauses in national constitutions that limit collaboration beyond national borders;[65]
- Perceptions that collaborative approaches are more complex and time-intensive;[66]
- Perceptions that it is more expensive to produce within the EU through common procurement rather than to buy from abroad (mainly from the United States);[67]
- Short-term cooperation with other Member States is not sufficient to build trust;[68]

60 The efficiency scores of defence spending by Member State can be found in Table 3 of Annex I.

61 See Annex I, Section 5.3.

62 European Defence Agency, Defence Data Portal.

63 J. J. Andersson, Buying weapons together (or not) – Joint defence acquisition and parallel arms procurement, European Union Institute for Security Studies (EUISS), Brief 7, April 2023. The briefing differentiates acquisitions from procurement.

64 The European Defence Agency notes that data is not reported for several Member States including some that do carry out collaborative defence equipment procurement. The share is likely to be higher than the estimated level.

65 R. Beetsma, M. Buti and F. Nicoli, 'Defence as a European Public Good: Delivery and Financing', *How to Ensure Defence Capabilities for Europe? Economic and Fiscal Consequences*, EconPol Forum, Vol. 25, July 2024. The article specifically mentions such clauses in the German, Italian and Irish constitutions.

66 K. Hartley and D. Braddon, 'Collaborative Projects and the Number of Partner Nations', *Defence and Peace Economics*, Vol 25(6), 2014, pp. 535–548; European Defence Agency, 2022 Coordinated Annual Review on Defence Report, November 2022.

67 I. Ioannides, EU Defence Package: Defence Procurement and Intra-Community Transfers Directives – European Implementation Assessment, EPRS, European Parliament, 2020, pp 97-98.

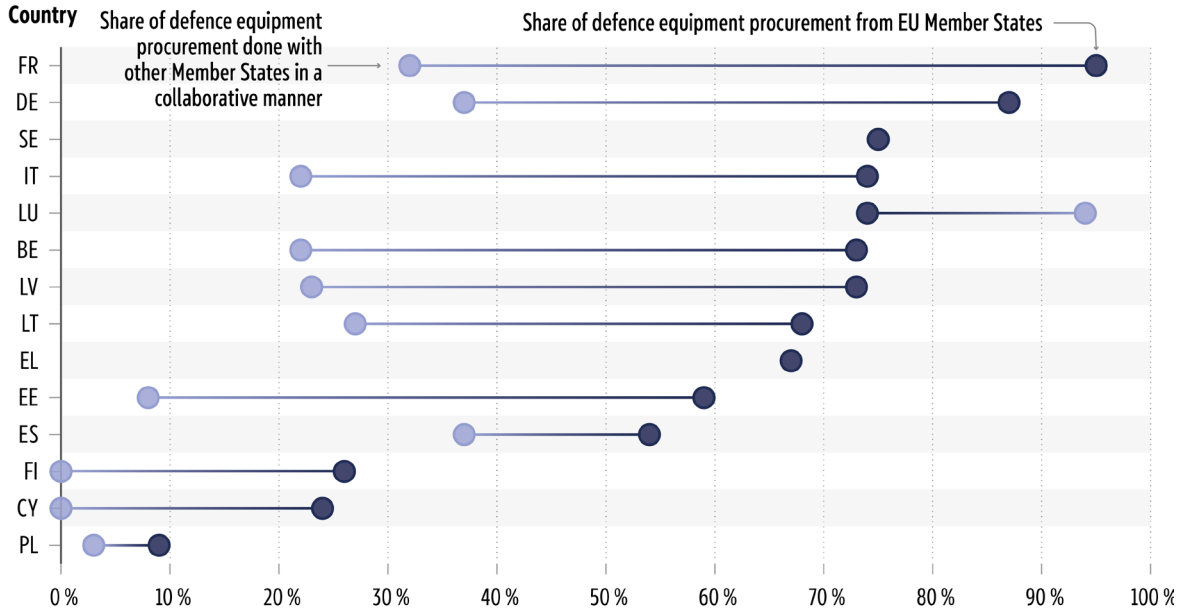
68 V. Kanniainen and J. Lehtonen, 'Cooperative Procurement in Building National Defence: Why Are There So Few?', *Defence and Peace Economics*, Vol. 31(2), 2020, pp. 201-219.

- Different national preferences for equipment quality and timeline;[69]
- Different operational requirements for national defence systems;[70] and
- Delays in delivery of equipment.[71]

Countries that do not report collaborative procurement are more likely to be (a) smaller EU Member States with lower defence equipment spending, or (b) newer EU Member States with less historical precedent for multilateral cooperation on defence matters. A report by the European Court of Auditors on the EU preparatory action on defence research (PADR) found that project coordinators and participants were mainly from Member States with large defence industries and that cross-border collaboration between large companies and small and medium-sized enterprises (SMEs) was 'difficult in some cases'.[72]

Data from the European Defence Agency do not indicate which Member States participated in collaborative defence equipment procurement, the countries from which the procurement was made, nor the depth of the collaboration. Nonetheless, the available data reported from 12 Member States suggests the higher the share of defence equipment procurement from the EU Member States, the higher the share done in a collaborative manner with other European countries (see Figure 6).

Figure 6 – Greater collaborative procurement is associated with a higher share of defence equipment procured from EU Member States



Source: Annex I based on latest data available from the European Defence Agency.

[69] H. Baudouin, 'A Primer to Collaborative Defence Procurement in Europe: Troubles, Achievements and Prospects', *Public Procurement Law Review*, Vol 17(3), 2008, pp 123–145.

[70] Baudouin.

[71] Baudouin.

[72] European Court of Auditors, The Preparatory action on defence research, 2023. The report concluded: 'The vast majority of PADR consortia were a continuation of cooperation between entities that had already worked together before the programme'.

3.4 Member States have limited bargaining power in procuring defence equipment from third countries

Based on an analysis of publicly available defence contracts, the research estimates that about 37 % of the EU's defence equipment procured was sourced from outside the EU (see Section 3.2, Figure 5). An estimated 12 % of third-country defence spending was in collaboration with other European countries.[73] Thus, procurement of defence equipment from third countries is primarily done through bilateral agreements. As a result, Member States may pay different prices for the same defence equipment. Smaller Member States or those that place smaller orders may pay higher unit prices.

Bilateral development and procurement agreements with third countries does not leverage European economies of scale, whereas coordinated spending could boost bargaining power for all Member States and lead to lower unit prices of defence equipment purchases.

3.5 Member State and EU spending on defence innovation is low and fragmented

Defence software and technology have become a defining element of new weapons systems.[74] Traditional European defence industry players face competition from large technology companies and small defence technology start-ups known as 'new defence'.

The United States and China are in a stronger position than the EU. They are the top two producers of high-impact research on six critical technologies in defence, space and security (see Table 2). China is especially dominant in research on advanced aircraft engines including hypersonic aircraft. The US leads in small satellites and space launching systems.

It is not clear if the level of defence innovation spill-over to the civilian sector is higher or lower in Europe compared to the US. An analysis found that 28.7 % of defence patent families in the European Patent Convention were dual use, compared to 64.7 % for the US Patent and Trademark Office.[75] However, other research suggests that European companies have more military citations per employee in civilian patents than US companies.[76]

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[73] European Defence Agency, Defence Data Portal. The EDA reported €9 875 million in collaborative defence equipment procurement and €7 895 million in European collaborative defence equipment procurement in 2021. The difference was assumed to be the amount of collaborative procurement with third countries. The figure was then divided by the estimated amount of defence procurement from outside the EU (37 % multiplied by €43 058 million).

[74] S. Soare, P. Singh, M. Nouwens, Software-defined Defence: Algorithms at War, The International Institute for Strategic Studies, February 2023.

[75] F. Caviggioli et al., 'Dual use inventions: identification and characterization using patent data', *Economics of Innovation and New Technology*, 2023.

[76] M. Acosta et al., 'Patents and dual-use technology: An empirical study of the world's largest defence companies', *Defence and Peace Economics*, Vol. 29, 2018.

Table 2 – Top five producers of research on critical defence, space and security technology

Critical technology	Top five producers of high-impact research
Advanced aircraft engines (including hypersonic)	China (48.5 %), US (11.7 %), India (7.0 %), UK (3.9 %), Iran (3.6 %)
Drones, swarming and collaborative robots	China (36.1 %), US (10.3 %), Italy (6.1 %), India (5.2 %), UK (4.5 %)
Small satellites	US (24.5 %), China (17.3 %), Italy (7.8 %), Germany (4.4 %), UK (4.1 %)
Autonomous systems operation technology	China (26.2 %), US (21.0 %), UK (5.3 %), Germany (5.1 %), South Korea (3.6 %)
Advanced robotics	China (27.9 %), US (24.6 %), UK (5.5 %), Italy (4.8 %), South Korea (3.8 %)
Space launch systems	US (19.7 %), China (18.2 %), Germany (9.8 %), Canada (8.2 %), South Korea (6.5 %)

Source: Jamie Gaida, Jennifer Wong-Leung, Stephan Robin and Danielle Cave, ASPI's Critical Technology Tracker – The global race for future power. Australian Strategic Policy Institute – International Cyber Policy Centre, Policy Brief Report No 69 2023, Table 2. Note: Figures in parentheses are the share of global research.

Stable public spending on defence research and technology (R&T), which is a share of R&D,[77] is crucial for fostering a healthy defence innovation ecosystem. Defence research can take up to 20 years to generate capabilities that defence ministries can use.[78] This long lead-time contrasts strongly with the seven-year budgetary cycle of the EU multiannual financial framework.

Nevertheless, the bulk of public defence innovation spending is at the national level. European economies of scale, which could increase the value per euro spent, are therefore missed. EU Member States spent about 1.4 % of their defence budgets on research and technology in 2022, translating to about €3.5 billion.[79] Only about an estimated 7.2 % of Member State R&T spending was in collaboration with at least one other Member State.[80] Through the European Defence Fund, the EU provides financial incentives to boost collaborative defence research and capability-driven development. The maximum EU contribution for the 2024 work programme is €51 million for research and €339 million for capability-driven development.[81] Based on budget figures from 2021 to 2024, about 4 % of funding (€183 million) was dedicated to disruptive technologies.[82]

The work programme includes a cross-cutting 'Framework partnership agreement for a defence medical countermeasures alliance' to support biodefence measures. The Health Emergency Preparedness and Response Authority (HERA), which was launched in response to the COVID-19 pandemic, is involved in two projects in the 2024 work programme to boost a robust EU-wide system of medical countermeasures. The RESILIENCE project, which has an overall budget of €50 million (the EU provides about €25 million), seeks to develop and test novel medical

[77] The European Defence Agency defines R&D as 'Any R&D programmes up to the point where expenditure for production of equipment starts to be incurred. R&D includes R&T'. R&T is defined as 'Expenditure for basic research, applied research and technology demonstration for defence purposes. It is a subset of R&D expenditure'.

[78] European Court of Auditors.

[79] European Defence Agency Defence Data 2022 reports EU27 defence R&T expenditure was €3 537 million and total defence expenditure was €239 750 million.

[80] European Defence Agency Defence Data 2022 reports EU27 collaborative defence R&T expenditure was €253 million.

[81] European Defence Agency, 2024 Work Programme, Part I.

[82] European Defence Agency, 2024 Work Programme, Part 2, Appendix 5.

countermeasures.[83] The Counteract project, which has an overall budget of €100 million (the EU provides €50 million), seeks to builds a network that can successfully deploy medical countermeasures in the case of a chemical, biological, radiological or nuclear (CBRN) attack.[84] [85]

Overall, the level of EU and Member State spending on defence innovation is low in absolute terms and as a share of total spending. The US Department of Defence allocated about €22 billion, or about 2.8 % of its annual budget, for science and technology, which 'is seen as the pool of knowledge necessary for the development of future military systems'.[86] The US has also scaled up its investments in the Biomedical Advanced Research and Development Authority (BARDA), which operates with a budget that is about three times larger than the EU's HERA and has greater flexibility. The 2025 Fiscal Year President's budget includes an estimated €90 million (US$95 million) to boost development and production of medical countermeasures.[87]

[83] European Commission, RESILIENCE-R-2023, DG DEFIS website.

[84] European Commission, COUNTERACT, DG DEFIS website.

[85] European Commission, European Defence Fund – Performance, downloaded 10 September 2024. The source notes that €2.6 billion will be directed to collaborative defence research for 2021-2027. This amount was divided by seven to get an estimated annual figure.

[86] Congressional Research Service, FY2025 Budget Request: Department Defence-Military (Subfunction 051), October 2024. Congressional Research Service, Defense Primer: RDT&E, updated February 2024.

[87] FY 2025 President's Request: ASPR Highlights, ASPR website.

4. How can deepened cooperation help leverage European economies of scale and boost European defence spending quality and efficiency?

Section 3 highlighted five challenges that hinder efficient European defence spending. This section investigates how leveraging European economies of scale in four areas can generate gains, including budgetary savings (see Table 3).

Table 3 – Overview of challenges and policy options to deepen cooperation and leverage European economies of scale

		Leverage European economies of scale in :			
		Military forces and strategic assets (Section 4.1)	Defence equipment procurement from EU countries (Section 4.2)	Defence equipment procurement from non-EU countries when an EU equivalent is not available (Section 4.3)	Research on emerging disruptive technologies (Section 4.4)
Challenges	The EU has a large military capacity, but sub-optimal readiness (Section 3.1)	✓			
	Defence equipment procurement is fragmented and inefficient (Section 3.2)		✓	✓	
	Collaboration among Member States on defence equipment procurement is uneven (Section 3.3)		✓		
	Member States have limited bargaining power in procuring third-country defence equipment (Section 3.4)			✓	
	Member State and EU spending on defence innovation is low and fragmented (Section 3.5)				✓

Source: EPRS

4.1 Military forces and strategic assets

4.1.1 Avenues for EU action

The European Parliament called to boost European military cooperation at armed forces level, for a stronger and more capable EU security provision.[88]

EU initiatives, such as the Strategic Compass, aim at boosting the EU's capacity to deploy troops more efficiently and reinforcing the ability to respond to current and future challenges. A key element of the Strategic Compass is the creation of a new EU Rapid Deployment Capacity (RDC) to address crises beyond the EU's borders. The RDC, scheduled to stand ready from 2025, will be a modular force of up to 5 000 personnel, consisting of modified EU battlegroups and additional forces combining Member States' forces and capabilities. Parliament has already highlighted the high potential of this new capacity and the importance of its full implementation.[89]

By streamlining decision-making processes and making full use of the new EU RDC, the EU could enhance its capability to swiftly deploy troops at EU-scale level and take decisive action to guarantee the safety and security of its citizens. The role of the MPCC will be essential to ensure effective command and control of the troops.[90] This could be a first step to moving operational command of current CSDP operations, executive and non-executive, from the national to the EU level, ensuring better coordination and better use of resources.

To improve its military readiness, as Parliament underlined,[91] the EU could deepen its efforts on military mobility[92] and develop an integrated approach to logistics,[93] including a solid transport network, logistic hubs, fuel infrastructure, repair capacity and stocks for spare parts and ammunition. To optimise movement of military personnel and their materiel, particular attention should be paid to dual-use transport infrastructure corridors across the Trans-European Network, the EU-wide network of railways, inland waterways, short sea shipping routes and roads. The CARD,[94] conducted by EDA in close coordination with the European Union Military Staff (EUMS), already stressed the importance of synchronising digitalisation, and further reducing legal barriers to allow fast movement in all domains and reduce deployment times.

By pooling resources in flagship European defence projects of common interest, the EU could also benefit from its scale dimension to narrow critical gaps in strategic enablers, ensuring effective deployment.[95] Strategic enablers, such as space communication assets, medical assets, strategic airlift, and cyber-defence capabilities are recognised as critical to ensuring assets required for missions and operations, as well as for the EU RDC, are available.

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88 European Parliament resolution of 28 February 2024 on the implementation of the common security and defence policy – annual report 2023 (2023/2119(INI)).

89 European Parliament, 2023/2119(INI).

90 EEAS, Military Planning and Conduct Capability (MPCC), factsheet, 2023.

91 European Parliament resolution of 11 December 2018 on military mobility (2018/2156(INI)).

92 Strengthening military mobility is a key task of the new Defence Commissioner.

93 D. Fiott, Keep it Moving: From Mobility to Logistics in European Defence, CSDS Policy Brief, September 2024.

94 EDA, 2022 Coordinated Annual Review On Defence Report, 2022.

95 European Parliament resolution of 18 January 2023 on the implementation of the common security and defence policy – annual report 2022 (2022/2050(INI)).

Stepping up use of the Permanent Structured Cooperation (PESCO) framework would be crucial, structuring certain projects around the need to develop the required capabilities and strategic enablers and moving from the tendency to launch low-level and low-impact projects. [96] [97]

Considering the role of the space sector in Russia's war on Ukraine, a unified command and control body that can simultaneously deal with military and civil capabilities data – an EU Space Command – can also be considered to ensure military readiness.[98]

4.1.2 Assessment

The current scenario presents considerable potential for improved efficiency. More capable and coordinated military forces enhance the EU's ability to act as a unified entity in response to threats, regardless of their nature. Deploying troops involves significant logistical, training, and support resources and is an integral part of Member States' military capacity. The analysis suggests that using 49 % fewer resources would still lead to the same levels of efficiency in troop deployment, saving over €45.3 billion per year.[99] This result shows there are significant possibilities to improve efficiency and readiness of deployed troops at EU level.

This research carried out for EPRS explored scenarios of increased levels of deployed troops, a key factor to enhance military readiness, and the impacts on spending efficiency and waste reduction. The aggregate analysis reveals a negative relationship between the percentage of deployed troops and the total amount of waste. The quantitative analysis of the scenario found that on average each 1 % increase in the percentage of deployed troops could lead to budgetary savings for the EU of up to €3.2 billion per year.[100] Assuming that EU action could streamline processes and remove barriers in troop deployment, it could be possible to boost the level of deployed troops of 30 % and generate up to €11.2 billion in budgetary savings each year.[101]

These conclusions suggest that more coordination of deployed troops leads to greater efficiency in defence spending.

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96 D. Fiott, L. Simón, EU defence after Versailles: An agenda for the future, Policy Department for External Relations, European Parliament, 2023.

97 The International Institute for Strategic Studies, The coordination problem in European defence planning, IISS Commentaries, 2021.

98 European Commission, Joint Communication on Space Strategy For Security And Defence (JOIN(2023)9).

99 See Annex Section 4.1.

100 See Annex Section 5.1. This number is calculated by multiplying the total number of EU population by the estimated coefficient for waste reduction per capita (-7.255).

101 See Annex Section 5.1. This number is obtained by multiplying the total number of EU population by the estimated coefficient for a 30 % waste reduction per capita (-25.011).

Box 2: European Council on Foreign Relations defence index

The index developed by the ECFR assesses Member States' ability to maintain peace and security both within and beyond their own borders. The index examines territorial defence and crisis management, as well as countries' capabilities and commitments in both areas. To evaluate countries' capabilities, the index assesses defence spending, troops deployed in joint missions and operations, membership in and contributions to military alliances and permanent multinational forces, industrial cooperation, and military equipment.

To better understand the nature of the index and the indicators included in the analysis, see ECFR defence index.

To test the robustness of the conclusions and provide a comprehensive assessment of defence readiness, the analysis took account of a change in the variables analysed, using the European Council on Foreign Relations (ECFR) defence index.[102] The ECFR index is a composite measure that includes factors such as military capability and defence readiness, making it an appropriate measure for evaluating the efficiency of defence policies and expenditure. The analysis shows that, on average, Member States experience similar trends between their efficiency scores in deployed troops and their efficiency scores on the ECFR index level (see Box 2).

Increased efficiency could also have a positive impact on the integration of defence assets across Member States, promoting interoperability and better preparing military forces,[103] providing more valuable opportunities for training and skill development at the EU level (see Table 4). Building on existing programmes, deepened coordination in this field could reinforce mutual trust. This integration enhances the EU's ability to act as a unified force in response to external threats and improve the EU's capacity to manage conflicts, provide humanitarian assistance and increase resilience to shocks. This could also play a key role in deterrence,[104] which is an integral element of NATO's strategy and a top priority for the transatlantic Alliance.

Better military readiness could be a key factor for enhancing security and thus help to promote the rule of law. As specified by the Rule of Law Index developed by the World Justice Project,[105] 'security is one of the defining aspects of any rule of law society and is a fundamental function of the state. It is also a precondition for the realisation of the rights and freedoms that the rule of law seeks to advance'. The right to security is also a key factor for businesses, as they can operate more easily in an environment where they know the government can deal with security risks. Geopolitical volatility affects business organisations, limiting trading opportunities, posing threats to their workforce and affecting future growth.[106]

[102] The index has been used in the DEA analysis as an output measure, replacing 'deployed troops'. See Annex Section 5.1 – Robustness check for model 1.

[103] M. Smith et al., *The Diplomatic System of the European Union*, Routledge, 2015.

[104] P. Violakis, *Europeanisation and the Transformation of EU Security Policy: Post-Cold War Developments in the Common Security and Defence Policy*, (1st ed.), Routledge, 2018.

[105] World Justice Project Index 2023.

[106] AON, Top Risks Facing Organizations in Europe, AON website, 2023.

Table 4 – Cost of non-Europe in military forces and strategic assets

	Cost of non-Europe in military forces and strategic assets
Potential budgetary savings:	More coordination in spending for deployed troops could reduce the efficiency loss by at least €11.2 billion each year.
Other potential gains:	*Other economic impacts:* more predictable and secure operating environment for businesses *Social impacts:* enhanced security for individuals living in the EU, better protection of rule of law, increased mutual trust.

Source: EPRS.

4.2 Defence equipment procurement from EU countries

4.2.1 Avenues for EU action

As noted in Section 3.3, the level of cooperation between Member States in purchasing defence equipment from within the EU is uneven. European economies of scale could be leveraged in two ways: (1) engage Member States that have not yet collaborated on defence equipment procurement (widen cooperation); and (2) engage Member States in the preparatory phase before signing a collaborative agreement (deepen cooperation).[107]

In the EDA Ministerial Steering Board in 2007, Member States committed to boosting collaborative defence procurement to 35 %. In February 2024, the European Parliament called for more EU action to boost collaborative defence spending to meet this agreed target.[108]

At present, the EU is exercising its complementary executive capacity function to support deepened cooperation among Member States for defence equipment procurement in two ways

- Providing financial incentives. For example, the European Defence Agency provided an estimated €680 million[109] to support to collaborative development projects in 2024. The European Defence Industry Reinforcement through Common Procurement Act (EDIRPA) provides an estimated €310 million[110] in 2024 and 2025 to support joint procurement of ammunition, air and missile defence and platforms and to replace legal systems. In total, the EU's financial support for collaborative procurement was equivalent to about 10 % of Member State collaborative defence equipment spending in 2022.[111]
- Sharing information. The EU started to monitor national defence plans through the CARD in 2019. It published subsequent reports in 2020 and 2022.

[107] B. Heuninckx, 'Collaborative Defence Procurement: How to make it work', *Emerging Strategies in Defence Acquisitions and Military Procurement*, Chapter 7, Scopus, 2017.

[108] European Parliament resolution of 28 February 2024 on the implementation of the common foreign and security policy – annual report 2023 (2023/2117(INI)).

[109] EDF financial programming was €1.014 billion for 2024. For 2021 to 2027, about €2.6 billion was allocated to research (R&T), while €5.3 billion was allocated to capability design and development (R&D).

[110] European Commission, EDIRPA Work Programme - Procuring together defence capabilities, 2024.

[111] Latest data available from EDA 2022, downloaded October 2024.

Box 3: Coordinated Annual Review of Defence

The CARD generates an overview of defence activities across Member States. It identifies opportunities for collaboration and facilitates cooperation. Over time, the CARD is expected to support the gradual alignment of defence planning and capability development cycles across the Member States.

Source: Sebastian Clapp, European capability development planning, EPRS, European Parliament, March 2024.

In addition to these two actions, the EU could bolster its role as a neutral mediator to promote deepened cooperation between Member States on defence equipment of common strategic interest. For example, the European Defence Agency could bring together Member States to develop the 55 collaborative opportunities for capability development identified in the 2020 CARD report (see Box 3).[112] The EU could support Member States in drawing on available resources such as the Technical Support Instrument, to identify barriers to deepened cooperation and possible solutions.

Such EU action can help to normalise cooperation among Member States and make cooperation the default option rather than the exception.[113] This action could apply not only to defence procurement, but also to procurement for civilian needs, for example, on space technologies.

The European Parliament has drawn attention to the risk of dependency on third countries for such materials, especially in critical technologies for security and defence.[114] EU action to secure critical raw materials is thus needed to support European defence equipment production and procurement.[115] The Commission's list of critical raw materials, however, appears to exclude materials that are highly critical for the defence sector.[116] Ensuring a secure supply of graphite and aluminium is especially important, in light of its use in defence production and the risks to its supply chain.[117]

4.2.2 Assessment

Widening and deepening cooperation on defence equipment procurement has the potential to reduce costs. However, there is limited research on the scale of possible cost savings. A 2018 European Commission study presented an example concerning the production of combat aircraft. If only one of the three types of combat aircraft had been developed, the cost of R&D per unit could have been reduced by 41 % to 83 %.[118]

This research explored scenarios of deepened cooperation on defence procurement and the budgetary implications. These scenarios drew on reported data from Member States on the level of defence equipment procurement spending and the share that was in collaboration with other European countries.

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112 European Defence Agency, 2020 Card Report – Executive Summary.

113 S. Monaghan, Solving Europe's Defence Dilemma – Overcoming the Challenges to European Defence Cooperation, Center for Strategic and International Studies Brief, March 2023.

114 European Parliament resolution of 9 May 2023 on Critical technologies for security and defence: state of play and future challenges (2022/2079(INI)).

115 The Critical Raw Materials Act was adopted in April 2024: Regulation (EU) 2024/1252 of the European Parliament and of the Council of 11 April 2024 establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1724 and (EU) 2019/1020.

116 B. Girardi et al., Strategic raw materials for defence: Mapping European industry needs, The Hague Centre for Strategic Studies, January 2023.

117 B. Girardi et al.

118 European Commission, Staff Working Document of the European Commission accompanying the document 'proposal for a regulation of the European Parliament and of the Council establishing the European Defence Fund', SWD(2018) 345 final, 2018.

Due to missing data, the analysis scenario was built in segments. Data from four Member States (Portugal, Sweden, Spain and Italy) provide an insight into the impact of deepened cooperation at different levels of defence equipment procurement. The impact of deepened cooperation for the remaining Member States was then assumed to follow the same pattern as one of the four Member States, based on the level of defence equipment spending (see Table 5).[119] The potential budgetary savings were then estimated for each Member State and aggregated to the EU level (see Table 6).[120]

Table 5 – European collaborative procurement scenario

	Portugal	Sweden	Spain	Italy
Defence equipment procurement, 2021 [a]	€621 million	€1 677 million	€3 185 million	€5 923 million
European collaborative procurement, 2021 [a]	1.4 %	2.9 %	45 %	39 %
Member States with lower level of defence procurement [b]	SI, LV, EE, LU, BG, HR, SK, LT	CZ, RO, BE, DK, HU	FI, NL	EL, PL, FR, DE

Note: Four Member States (AT, CY, IE and MT) were identified as outliers and not included in the analysis.
Source: [a] Available from European Defence Agency Defence Data; [b] The correspondence of a Member State is based on the comparison between: (1) the Member State's level of defence equipment procurement; and (2) the level of defence equipment procurement among the four Member States estimated.

The quantitative analysis of the scenario found that each 1 % increase in the share of European collaborative defence equipment procurement could lead to overall EU budgetary savings of up to €93 million per year. Increasing deepened cooperation to the target of 35 % could potentially reduce the level of inefficiency loss by €3.2 billion each year (see Table 7).[121] Moreover, as noted in Section 3.3, an increase in European collaborative procurement can lead to a higher share of procurement from European countries.

Deepening collaborative procurement arrangements – by involving more Member States and building a common interest from an earlier stage in the process – could have potential to further increase budgetary savings. As noted in one study, a collaborative procurement arrangement between two Member States could lower product costs per unit by 9 %, while involving three Member States would reduce the cost per unit by 14 %.[122]

[119] See Annex I, Section 5.2.

[120] Austria, Cyprus, Ireland and Malta were excluded due their being identified as outliers in the analysis.

[121] See Annex I, Section 5.2 for more information about the scenario analysis. The estimates for the scenarios of 35 % and 40 % were extrapolated.

[122] B. Heuninckx, pp. 123-145.

Table 6 – Scenarios of deepened cooperation on EU defence procurement

What if European collaborative procurement increased to:	Potential budgetary savings	Defence equipment equivalent
30 %	€2.8 billion	28 Eurofighter aircraft or 100 Leopard 2 A8 battle tanks
35 %	€3.2 billion	32 Eurofighter aircraft or 114 Leopard 2 A8 battle tanks
40 %	€3.8 billion	38 Eurofighter aircraft or 136 Leopard 2 A8 battle tanks

Source: Annex I – Section 5.2. Estimates for 35 % and 40 % are extrapolated. Defence equipment equivalent is based on the estimated price of €100 million for a Eurofighter aircraft or €28 million for a Leopard 2 A8 battle tank.

Increasing the share of European collaborative procurement could generate other possible gains (see Table 7). Most notably it could reduce the variation across Member States in defence equipment and capabilities and promote an upward convergence to meet EU security needs. Boosting a market for more units of the same defence equipment could boost the defence industry, and R&D to develop new capabilities, which are aligned with the EU's needs and technological advancement to help ensure the EU defence sector's competitive standing in the world. Deepened cooperation may also lead to a lower risk of corruption due to the need to share information and the involvement of more institutions, which could provide additional safeguards. The defence industry is considered to have a high risk of corruption because industry and defence ministries are closely linked.[123] Reducing the variation in the types of defence equipment could open opportunities for shared maintenance, which could lead to budgetary savings as well as reduced environmental impact.[124]

The EU could consider refining its financial incentives to take account of large defence companies' value chain structures and to promote certain types of companies (e.g. SMEs or 'new defence'). For example, the EDIRPA will support two projects to boost air and missile defence systems. One involves nine Member States (Belgium, Cyprus, Denmark, France, Greece, Hungary, Romania, Slovenia, Spain) while the other will involve six Member States (Austria, Bulgaria, Germany, Greece, Latvia, Slovenia).[125]

An EPRS study found while some procurement awards appeared to be awarded on a national basis, the recipients were national subsidiaries of foreign companies. It was thus likely that only some of the work would be carried out in the country where the procurement was awarded.[126] Financial incentives provided by the EU should help bring together Member States and national companies that would otherwise not be able to collaborate.[127]

Financial incentives offered by the EU could also provide a positive signal to the defence industry and lead to co-financing and additional investment. For example, the European Commission reports

123 European Commission, High-risk areas of corruption in the EU: A mapping and in-depth analysis, 4 November 2024.

124 J-P Maulny, et al., Magnitude of the Cost Structure of Defence Research and Development Programmes and Optimal EU Intervention to Incentivize Cooperation, Institute for International and Strategic Affairs (IRIS), 2018.

125 European Commission, EU boosts defence readiness with first ever financial support for common defence procurement, Press Release, 14 November 2024

126 I. Ioannides.

127 European Court of Auditors. The report concluded: 'The vast majority of PADR consortia were a continuation of cooperation between entities that had already worked together before the programme'.

that €513 million provided by the Act in Support of Ammunition Product (ASAP) generated €1.5 billion total spending.[128] In other words, €1 in EU investment led to €3 in total EU and industry investment. Such action could provide a boost to the EU defence industry and to the right to engage in work and the freedom to conduct a business (Articles 15 and 16, EU Charter of Fundamental Rights).

Table 7 – Cost of non-Europe in European defence equipment procurement

	Cost of non-Europe in European defence equipment procurement
Potential budgetary savings:	Up to €3.2 billion could be saved if Member States achieved the collaborative defence equipment target of 35 % agreed at the EDA Ministerial Steering Board in 2007. The budgetary savings could be potentially greater with wider and deepened cooperation.
Other potential gains:	*Other economic impacts:* A stronger and more integrated European defence industry, for example, a 10 % increase in European collaborative procurement could lead to an estimated 40 % increase in the procurement of defence equipment from the EU. It could also lead to more R&D and development of future capabilities and upward convergence in military capabilities across the EU. *Social impacts:* More jobs in a strengthened European defence industry; higher returns on public spending; support the right to engage in work (Article 15, CFR) and the freedom to conduct a business (Article 16, CFR). *Environmental impacts:* More interoperability could imply longer defence equipment lifespans.

Source: EPRS.

4.3 Defence equipment procurement from non-EU countries when an EU equivalent is not available

4.3.1 Avenues for EU action

The EU could help boost Member States' bargaining power by facilitating joint procurement of defence equipment from third countries when there is no European equivalent. As noted in Section 3.2, about 37 % of defence equipment is procured from third countries. The United States alone represents about 22 %, or about one in five euros spent on defence equipment. The high level of procurement from the US may not imply that similar defence equipment is not produced in the EU, but may rather reflect the security guarantee that US equipment can offer in the context of NATO. According to Recommendation #10 of the Draghi Report, defence equipment procurement from third countries may be justified in the short-term, while in the longer-term and to support strategic autonomy, defence equipment should increasingly be procured from EU countries.[129]

This policy option could be operationalised by an 'extension of the European defence industry through common procurement (EDIRPA) logic', as called for in the European defence industrial strategy. This extension could consider:

[128] European Commission, ASAP Results - Boosting ammunition production, 2024.

[129] The recommendation is as follows: 'Improved coordination and combine the acquisition of US systems by sub-groups of EU Member States'.

- including all types of defence equipment that meet EU capability needs and for which no European equivalent is available;[130]
- allowing for procurement from an approved list of third countries that sell defence equipment for which no European equivalent is yet available.

This policy option could also be extended to procurement for civilian purposes closely linked with the defence sector, e.g. space technologies.

Building on existing bilateral partnerships between Member States and third countries (such as the global combat air programme), agreements between the EU and like-minded countries to develop and procure defence equipment of mutual strategic interest could also be considered.

Box 4: Acquisition of F-35A aircraft

The US-produced F-35A combat aircraft is desirable for its advanced stealth, situational awareness and interoperability with NATO forces. Annex I presents data on orders of the F-35A model from seven EU Member States for a total of 261 units. Comparing contracts across countries is challenging due to the inclusion of different support elements (e.g. engines, spare parts, training), depending on the buyer's needs. Assuming such elements represent a small share of the total contract value, we estimate that the unit price of an F-35A aircraft varied from €131 to €203 million across the seven EU Member States. Assuming that all Member States were offered the lowest unit price of €131 million per F-35A aircraft could have led to overall savings of €10.3 billion (for all years and units considered), or 23 % of the actual amount spent.

Source: Annex I, Section 5.3, Table 20.

4.3.2 Assessment

The case for joint acquisition and procurement from third countries is strongest for defence equipment that is sought after by multiple Member States, but not produced in the EU. The greater the number of participating Member States, the bigger the potential gains leveraged by economies of scale.

Box 5: Procurement of K9 Thunder aircraft

The K9 Thunder is an artillery weapon produced by South Korea that can fire NATO standard ammunition up to 60 kilometres. The research presented in Annex I found that Poland ordered 212 units for a unit price of €11.3 million, while Romania ordered 54 units for a unit price of €17 million. If Romania had obtained the same price as Poland, it could have saved more than €300 million (for all years and units considered). The two countries could have saved 10 % on the procurement of the K9 Thunder.

Source: Annex I, Section 5.3, Table 21.

The research investigated two cases with available data – the K9 Thunder from South Korea and the US F-35A aircraft (see Boxes 4 and 5). Assuming that Member States had all been offered the most favourable price, savings of 10 % to 20 % could be possible.

The difference in unit price paid by uncoordinated defence equipment procurement from third countries was 10 % to 20 %, depending on the type of military equipment (see Section 3.5). By pooling resources and bargaining power, Member States could jointly procure the same number of units at a lower unit price. The use of joint procurement could be expected to lead to lower and more uniform prices for all Member States.

The level of potential budgetary savings was estimated as follows: Figure 7 shows that about 37 % of spending on defence equipment went to non-EU countries. In 2021, Member States spent €43 billion on defence equipment, of which €2 billion was spent in a collaborative manner with third countries. Based on these figures, Member States spent an estimated €15 billion on defence

[130] In 2024, the EDIRPA was limited to the common procurement of ammunition, air and missile defence and platforms and replacement of legacy systems.

equipment from third countries. Assuming that joint procurement could lead to 10 % to 20 % lower prices, the estimated budgetary savings could reach €1.5 to €3.0 billion each year.[131] In addition to price, joint procurement could boost bargaining power with respect to the timeline for delivery and specific features to better meet EU capability needs and interoperability with European defence equipment (see Table 8). In short, joint procurement could support the procurement of defence equipment better suited to European defence needs.

Table 8 – Cost of non-Europe in joint procurement from third countries

	Cost of non-Europe in defence equipment procurement from third countries
Potential budgetary savings:	Member States could save up to €3.0 billion by more coordinated defence equipment procurement from third countries
Other potential benefits:	*Other economic impacts:* Upward convergence in military capabilities across the EU *Social impacts:* Better returns on public spending *Environmental impacts:* More interoperability could imply longer defence equipment lifespans

Source: EPRS.

4.4 Research on emerging disruptive technologies

4.4.1 Avenues for EU action

The Letta Report recalls the four freedoms of the single market – the free movement of goods, services, people, and capital – and proposes adding a fifth freedom to enhance research, innovation and education.[132] The report notes:

> *'The fifth freedom transcends merely facilitating the movement of research and innovation outputs; it critically entails embedding research and innovation drivers at the core of the Single Market, thereby fostering an ecosystem where knowledge diffusion propels both economic vitality, societal advancement and cultural enlightenment. Under this framework, the EU will be better suited to position itself not only as a global leader in setting ethical standards for innovation and knowledge diffusion, but a creator and a maker of new technologies – and their evolutionary patterns – developed and deployed in a manner that respects freedom, privacy, security, and benefits the most.'*

This fifth freedom is relevant to the defence sector where European economies of scale could increase the feasibility of financing 'high-risk, high-reward' defence research. Deepened cooperation across Member States could increase the value of existing investment in defence R&T and support a common vision of strategic priorities.

The EU could help to improve the quality of European defence innovation spending through its complementary executive capacity. Building on CARD and Capability Technology Groups (CapTechs),[133] managed by the European Defence Agency, the EU could help to pool and align

[131] The estimate is based on 2021 data, because EDA figures for collaborative defence equipment procurement were not available for 2022.

[132] Letta.

[133] The Captechs are: (1) Technologies, components and modules; (2) Radio frequency sensors technologies; (3) Electro-optical sensor technologies; (4) Communication information systems and networks; (5) Materials and structures; (6) Missiles and munitions; (7) Aerial systems; (8) Ground systems; (9) Guidance, navigation and control; (10) Naval systems; (11) Simulation technologies; (12) CBRN and human factors; (13) Cyber research and technology; (14) Energy and environment; (15) Space.

defence innovation expertise and spending with common European strategic priorities in the short, medium and long-term (from 2040 and beyond).[134] It could also promote a common terminology and interoperability across Member States. The European Parliament considers that 'the EDA is well placed to ensure the alignment of innovation activities among European actors in the defence sector'. Parliament thereby 'calls for the strengthening of its role in providing support'.[135]

Pooling national spending on defence innovation could help finance a European defence innovation agency similar to the Defence Advanced Research Projects Agency (DARPA) in the United States. The level of aggregated EU spending on R&T (€3.5 billion in 2022) is comparable to the annual budget of DARPA (USD 4.2 million – approximately €3.8 billion), which focuses on developing emerging technologies for the military. Aggregated EU spending on R&T also exceeds the budget of the United Kingdom's Advanced Research and Invention Agency (ARIA).[136] Complementary measures to ensure patent protection and address barriers preventing defence innovation spill-over to civil applications could also be envisioned.

EU action to boost the quality of defence innovation spending could complement the proposed scale-up of spending on defence innovation as reflected in the defence innovation and SME support scheme (EUDIS),[137] and the newly created Defence Equity Facility with the European Investment Bank, which will invest up to €500 million in SMEs with high defence innovation potential.[138] A cooperation between HERA and the EIB (HERA Invest) is also relevant for defence innovation, considering that its first investment agreement is for a technology to address CBRN threats in particular biotoxins.[139]

The EU could also improve alignment and synergies in defence innovation research financing with other initiatives not directly oriented towards the defence sector (see Table 9). Cutting financing for basic research while at the same time increasing financing for downstream defence research may be counterproductive in increasing defence sector competitiveness.[140] Drawing on NATO financing and support could help develop defence capabilities on a broadened EU-NATO scale.

Table 9 – Overview of EU financing instruments that could indirectly support defence research innovation

Programme/initiative	Description	Financing
European Research Council[1]	Long-term funding for frontier research	€11.6 billion for physical sciences and engineering
Marie Skłodowska-Curie Actions[2]	Doctoral education and postdoctoral training	€47.5 million provided in 2022 to train PhD candidates in 14 industrial

134 European Defence Agency, Enhancing EU Military Capabilities Beyond 2040, Main Findings from the 2030 Long-Term Assessment of the Capability Development Plan, Brussels, 2023.

135 European Parliament resolution of 9 May 2023 on Critical technologies for security and defence: state of play and future challenges (2022/2079(INI)).

136 The agency established in January 2023 has an initial GBP800 million annual budget. See N. Gaind, 'The UK's $1-billion bet to create technologies that change the world', *Nature*, 18 September 2024.

137 EU Defence Innovation Scheme (EUDIS).

138 European Commission, Joint Communication on A new European Defence Industrial Strategy: Achieving EU readiness through a responsive and resilient European Defence Industry. JOIN(2024) 10 final.

139 European Commission, First HERA Invest agreement signed to support research and development in cross-border health threats, 7 October 2024.

140 Florin Zubașcu, 'Horizon Europe budget to be cut by €2.1B, as defence research gets a €1.5B boost', *Science Business*, February 2024.

Programme/initiative	Description	Financing
		doctoral programmes and develop skills for industry.
European Innovation Council[3]	Support and scale-up breakthrough technologies and innovations.	28 % of projects supported in 2023 (€3.19 million) were in digital, industry and space
EU space programme[4]	Support earth observation, navigation and protection and secure communication.	€2 billion per year for 2021-2027
NATO Science for Peace and Security (SPS) Programme[5]	The programme finances collaborative, applied R&D and capacity building projects with dual-use application in security and defence.	Estimated €12 million per year
NATO Innovation Fund	A venture-capital fund supporting companies scale up deep technologies to support defence and security.	Estimated €1 billion in assets, which may change over time
Defence Innovation Accelerator for the North Atlantic (DIANA) accelerator programme	Organised within NATO to support the scale-up of deep tech.	Projects are funded by NATO Innovation Fund
Defence Equity Facility[6]	Help to attract venture capital and private equity to support European companies developing defence technologies with a 'dual use' potential.	Estimated €175 million in commitments from the European Defence Fund and the European Investment Fund for four years (2024-2027). It is expected to draw in up to €500 million.
HERA Invest[7]	Cooperation between HERA and European Investment Bank to support research and development on pressing cross-border health threats.	€100 million addition to the InvestEU programme.

Source: EPRS. [1] European Research Council Dashboard, [2] MSCA awards €429.4 million for doctoral programmes. [3] The European Innovation Council, Impact report 2023: Accelerating Deep Tech in Europe, 2024. [4] European Commission, EU Space Programme Overview – Factsheet. Downloaded 25 September 2024. [5] NATO, Science for Peace and Security Programme, report. [6] European Investment Fund, Defence Equity Facility, downloaded 18 November 2024. [7] European Health Union: HERA Invest offers €100 million for innovative solutions to health threats, July 2023.

4.4.2 Assessment

Leveraging European economies of scale in defence innovation spending could generate budgetary efficiencies and support a more coherent and robust European defence innovation industry. Drawing on an analysis of scientific documents, patent applications and high-tech exports, a research study suggests that there is potential room to increase the level of EU research output by up to 25 %

without changing the financing levels.[141] This finding suggests that up to €820 million could be gained each year by deepening cooperation in defence innovation.[142] The budgetary savings could help to finance a 'European DARPA'.

Deepened cooperation across Member States could boost defence innovation spill-over to civilian uses. Research has found that 'Military technologies characterised by a broader technological scope, a larger team of inventors, or a wider geographical protection are more likely to provide a knowledge base for further civilian developments'.[143] Long-term, stable and European-scaled defence innovation priorities could also provide a strong signal to the labour market and increase availability of highly qualified scientists and engineers across the continent for the defence sector and the development of a 'new defence industry'.[144] Such action could thus support the right to engage in work and the freedom to conduct a business (Articles 15 and 16, EU Charter of Fundamental Rights).

Increased defence innovation spending would be likely to generate positive macro-economic impacts. Based on a review of studies, the EIB concludes that the 'growth effects of military R&D spending are found to be considerably higher' compared to overall military spending.[145] One study estimated that a 10% increase in public R&D spending could lead to a five to six percentage point increase in private R&D spending while boosting productivity, which is linked with competitiveness.[146] However, other research from the United States concludes that increases in defence R&D do not lead to increases in productivity over a 15-year horizon (see Table 10).[147]

Table 10 – Cost of non-Europe in defence innovation

	Cost of non-Europe in defence innovation
Budgetary impacts:	Up to €820 million could be saved through European economies of scale and reinvested in a 'European DARPA'.
Other impacts:	*Other economic*: More technological breakthroughs with defence and civil applications; increased European defence industry competitiveness, including 'new defence'. *Social*: Increased high-skilled job opportunities directly linked to defence innovation and the defence sector more broadly, which could support the right to engage in work (Article 15 CFR) and the freedom to conduct a business (Article 16 CFR) .

Source: EPRS.

141 M Halaskova et al., 'Research and development efficiency in public and private sectors: An empirical analysis of EU countries by using DEA methodology', *Sustainability*, Vol. 12(17), p.7050, 2020. Data specifically for defence R&D investment are not presented.

142 Member States spent €3 537 million on R&T in 2022, of which €253 million in collaboration with other European countries. Of spending on R&T not done in collaboration, 25 % represents an estimated €820 million.

143 F. Caviggioli, et al., 'Dual use inventions: identification and characterization using patent data', *Economics of Innovation and New Technology*, 2023.

144 Ibid.

145 European Central Bank, The EU's Open Strategic Autonomy from a central banking perspective, Occasional Paper Series, Revised December 2023.

146 E. Moretti et al., 'The intellectual spoils of war? Defense R&D, productivity, and international spillovers', *Review of Economics and Statistics*, 2019.

147 A. Fieldhouse and K. Mertens, The Returns to Government R&D: Evidence from U.S. Appropriations Shocks, Federal Research Bank of Dallas, Updated December 2023.

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Annex

Building a common EU defence: A budgetary perspective

The report provides an in-depth analysis of defence spending across European Union Member States, focusing on how increased cooperation and integration could lead to significant cost savings and efficiency gains. It explores the potential benefits of creating a more unified European defence union. By enhancing cooperation, Member States could realise economies of scale and improve synergies, ultimately strengthening Europe's position on the global stage.

The analysis presented in this report is grounded in a comprehensive examination of defence spending and performance metrics across all Member States. The methodology involves a comparative analysis of how different Member States allocate resources and achieve defence outcomes. The rates of budgetary waste for the entire amount spent on defence are quite high.

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Executive summary

The onset of Russia's war on Ukraine in 2022 has starkly highlighted the fragile state of European defence, serving as a wake-up call to Western states about the urgent need to reassess and strengthen their defence capabilities (Perot, 2023). This conflict has underscored the instability of Europe's security environment, which is increasingly challenged by geopolitical shifts, cyberattacks, terrorism, climate change, and hybrid warfare. In response to these evolving threats, Europe is at this time in a critical phase of redefining its defence policy, a process that is essential, not only for the armed forces of Member States, but also for the defence sector that supplies and supports these forces.

Historically, European defence spending has seen significant reductions, particularly following the end of the Cold War (Heuninckx, 2017). The combined defence budgets across EU Members decreased sharply from 2.6 % of GDP in 1989 to 1.8 % of GDP in 1998. However, recent geopolitical developments, particularly Russia's annexation of Crimea in 2014 and the ongoing conflict in Ukraine (2022), have prompted Member States to reconsider their defence expenditure and strategic priorities. Between 2015 and 2023, defence spending in Member States increased by 50 %.

European defence has traditionally been characterised by cooperation under the NATO umbrella, where member states' military budgets have remained distinct, largely to preserve national sovereignty (Besch, 2023). However, the current security landscape has spurred initiatives aimed at deeper integration and efficiency. The EU global strategy (EUGS), launched in 2016, and the establishment of the Permanent Structured Cooperation (PESCO) are significant steps towards a more coordinated and efficient European defence. These initiatives aim to leverage the combined defence budget of €265 billion in 2022, positioning Member States as the second-largest defence spender globally. Nevertheless, even with these efforts, the combined budgets are insufficient to meet the increasingly defence and security objectives of the EU (Strandquist, 2021). Greater efficiency and significant added value can result from increased cooperation in defence, with coordinated actions and joint programmes allowing EU Member States to take advantage of economies of scale and improved synergies. By allowing a division of labour concerning military responsibilities, such cooperation could help individual nations focus on their areas of expertise, instead of trying to address all aspects of defence-related activities (Giumelli & Marx, 2023). Creating a more unified European defence market and more integrated forces, could lead to cost savings and efficiency gains of several tens of billions of euro, as well as strengthening Europe's position in the world (Cladi & Locatelli, 2015). The EU could do more, but it has made significant steps in this regard recently. This has included, among other things, increasing traditional defence spending with a new level of common security and defence spending at the EU level scheduled to increase by 22 % in the multiannual financial framework (MFF) for 2021 to 2027.

The report provides an in-depth analysis of the defence efficiency across Member States (MS), focusing on how increased cooperation and integration could lead to significant cost savings and efficiency gains. It explores the potential benefits of creating a more unified European defence market and more integrated forces, overcoming existing technical and political barriers. By enhancing cooperation, Member States could realise economies of scale and improve synergies, ultimately strengthening Europe's position on the global stage.

The analysis presented in this report is grounded in a comprehensive examination of defence spending and performance metrics across all Member States. The methodology involves a comparative analysis of how different Member States allocate resources and achieve defence

outcomes. The study uses a set of quantitative tools to evaluate efficiency, focusing on inputs such as defence expenditures per capita and procurement spending, and outputs like deployed troops and R&D achievements.

Our primary comparative analysis is utilised to assess the performance of the EU Member States. This approach allows us to calculate an 'efficient' production frontier, enabling the evaluation of each Member State's current position relative to this frontier. The resulting '(in)efficiency scores' from the comparative assessment highlight the inefficiencies that arise from the current division of competencies between the EU and its Member States. The selection of inputs and outputs is tailored to the specific aspects of the defence system under investigation.

To conduct the analysis, we use the framework provided by the microeconomic theory of production. Within this structure, each Member State functions as a decision-making unit that makes decisions based on inputs. Inputs must be consumed to produce outputs, which are the final results of the production process and can impact the defence system (Saulnier, 2020). Although there are various methods for determining inputs, when examining a country's performance, it is common practice to primarily focus on public spending.

The analysis focused on two specific areas in terms of expenditures: defence spending per capita and the deployment of troops (model 1), as well as defence procurement and technology R&D spending (model 2). These subdomains were selected because of their critical importance in the defence sector – troop deployment represents personnel, while defence procurement represents equipment. The analysis covers 2005 to 2022, a period marked by significant changes in the military landscape.

The aim of this paper is to determine how operating defence strategies at the national level, rather than a collective European level, incurs additional costs, or that there is a 'non-European' cost. The primary reason for these costs is the lack of integration among the military structures of Member States. Although European armed forces often collaborate in multinational or international contingents, they remain largely organised and managed at the national level. Similarly, most military equipment is procured, and personnel are trained and sustained by individual Member States. This 'standalone' approach not only creates vulnerabilities, but also increases the costs associated with the development, maintenance, and management of armed forces across Europe (Uttley & Wilkinson, 2016). Another significant factor contributing to these higher costs is the absence of a fully integrated defence market. The fragmentation into 27 separate national defence markets, each with its own administrative procedures and independent regulations, stifles competition and prevents the realisation of economies of scale in the defence industry. Realisation of economies of scale in the defence industry refers to the cost advantages that result when production is expanded, allowing the costs per unit of output to decrease. This is particularly relevant in the defence sector, where the production of military equipment, such as aircraft or tanks, involves significant upfront costs in research, development, and manufacturing. For example, if a single country orders a small batch of 50 aircraft, the unit cost per aircraft will be relatively high due to the distribution of fixed costs over a smaller number of units. However, if more EU countries collaborate to place a joint order of 200 aircraft, the fixed costs can be spread across a larger number of units, thereby reducing the unit cost per aircraft. This cooperative approach not only lowers expenditure for each participating country, but also enhances interoperability and standardisation across the European armed forces, leading to more efficient and effective defence capabilities.

Regarding the results of Model 1, the rates of budgetary waste for the entire amount spent on defence are quite high (the results are summarised in Table A below). The conclusions of the analysis

suggest that using 49 % fewer resources would still lead to the same levels of efficiency in the defence field, saving over €45.3 billion. This result shows that at the EU level, there are significant possibilities to improve efficiency of deployed troops. When examining data on the procurement and R&D sector, it is evident that there are significant rates of budgetary waste concerning management costs (Table A). To achieve the same results in R&D, 45 % fewer resources could be used. Community-level savings would amount to €10.9 billion if resources were allocated at the EU level and if the EU operated based on the efficient production function, using the actual output of the Member States. For both models, large EU nations show increased efficiency compared to small ones, a possible explanation being economies of scale and the existence of their own defence industry. Additionally, EU spending would allow for the use of economies of scale, leading to a further increase in efficiency (in terms of the potential for deploying troops).

Table A – Estimated waste in the production of services at national level, for the defence sector

Policy areas	Targets	Estimated waste at the MS level		
		Rate on total expenditure	€ billion	Return of scale
Defence	Deployed troops	49 %	45.3	Increased
	Defence R&D expenditures	45 %	10.9	Increased

Note: Model 1: input (defence expenditure per capita in 2015 constant prices); output (deployed troops per million inhabitants, particularly number of soldiers and other military personnel, working in other capacities).

Model 2: input (defence procurement expenditure: all sums used to procure defence equipment in 2015 constant prices); output (defence R&D expenditure: all sums used for R&D in defence in 2015 constant prices).

If we consider an comparative analysis with the USA and UK, the European states have smaller efficiences for each country. But, if we consider a contrafactual scenario with a EU27 v. USA v. UK, then this model has the same efficiency as the USA and is better than the UK.

According to the results obtained, Member States could take advantage of economies of scale, saving money and raising the level of defence spending if defence policies and spending were coordinated at European level.

The report provides an evaluation of the potential impacts of three distinct defence policy scenario on the EU's military capabilities and collaborative procurement. The results underscore the importance of strategic investment in deployment, collaborative procurement, and joint procurement with the US or another country to optimise defence outcomes, ensuring the EU remains well-prepared to address current and future security challenges. By taking advantage of economies of scale and leveraging collective bargaining power, Member States can enhance their defence capabilities cost-effectively and sustainably.

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1. Introduction

At a time when Russia triggered the worst security crisis since the end of the Cold War by invading Ukraine, European member states suddenly found themselves faced with the presence of a war on their borders, something unprecedented for over 80 years. As the possibility of direct aggression by a neighbor such as Russia could no longer be excluded, the actual state of the European states' armies – from the human resources to the military equipment – is of particular importance. However, since the end of Cold War and until 2022, European member states (MS) prioritized other areas of activity, defence falling to one of the last places on the public agenda. At the level of the MS, defence involves several components that intertwine and intercondition: military personnel, industry, budget expenditures, equipment procurement (Larivé, 2016).

According to international treaties (European treaties article 42 (7) of the Treaty on the European Union; Maastricht Treaty; Lisbon Treaty), the Member States have the exclusive right to ensure their own security and defence (Yalcin-Ispir, 2023). Therefore, for years, European security was only the 'summation' of the defence systems of the European member states under the umbrella of NATO. Although European countries work together, their military budgets have remained separate to preserve the sovereignty of member states in defence policy (Biermann, 2023).

In the last decade and especially after the invasion of Russia, the discussion regarding European defence system has returned to the actuality. Discussions about a security policy of the European Union are often linked to the changing geopolitics of the contemporary world and the uncertainties caused by them (Keukeleire & Delreux, 2022), as well as to industrial policy and the economic effects of military spending, as well as progress and innovation (Europa Publications, 2023). In the European area, discussions have re-emerged since the 2014 NATO summit that recommended the allocation of 2% GDP for defence, and have intensified especially since March 2022 (Conde et al., 2020). At the EU level, the Action and Training Plan in the field of defence was approved , which provides for the allocation of a constant proportion (at least 20% of the defence budget) to expenditures related to major equipment and common research and development at the EU level (Karampekios et al., 2017).

Since the end of the Cold War, most NATO members have significantly reduced their defence spending (Kirchner & Sperling, 2018). In 1990, NATO allocated 4.1% of GDP to defence, but by 2000, this value had decreased to 2.6%. NATO members from the Cold War era, excluding the United States, accounted for 39% of global defence spending in 1990; however, by 2020, this share had dropped to 27%. During the same period, NATO expanded from 15 to 29 members, with the United States largely compensating for the decline in defence spending among other members. After the Cold War, NATO encountered a classic free-rider problem (Dorn et al., 2023). Under Article 5 of the North Atlantic Treaty, an attack on one member is considered an attack on all members, allowing some countries to reduce their defence budgets while relying on the USA. This collective defence system enabled many countries to prioritize other budgetary needs for 20 years, taking advantage of the so-called peace dividend (Blum & Potrafke, 2020). By the time Russia invaded Ukraine and annexed Crimea in 2014, only three NATO countries – Greece, the United Kingdom and the United States – were spending more than 2% GDP on defence. At the NATO summit in Wales in 2014, members committed to increasing defence spending to at least 2% of GDP within ten years. By 2021, only 8 of the 29 NATO members had reached this threshold (The International Institute for Strategic Studies, 2020). Although only eleven of the thirty-one nations are expected to meet NATO's 2% target, the alliance defence spending is projected to reach 2.6%, largely due to the substantial contribution of the United States. In contrast, the defence budgets of the other 30 NATO members

will account for approximately 1.8% GDP. A large portion of NATO still appears to rely heavily on U.S. security assurances, even in the face of new geopolitical challenges (Lucarelli et al., 2012). Following the end of the Cold War, governments began to reduce their defence budgets, initially using peace dividends to expand welfare programs. As a result, for three decades, defence spending remained low and did not surpass the 1990 level (adjusted for inflation) until 2022 (Dorn et al., 2023).

In July 2013, the European Commission published the Communication 'Towards a more competitive and efficient defence and security sector' which assumed three objectives for a future roadmap: (i) an internal defence market in which European companies can operate without discrimination in all member states; (ii) a secure EU supply regime for the armed forces of all Member States; and (iii) a European research program covering both security and defence (Karampekios & Oikonomou, 2015; Breitenbauch et al., 2013). The important step in the field of European defence was achieved in December 2017 by the Council of the European Union which established an autonomous body, the Permanent Structured Cooperation (PESCO) (Conde et al., 2020). Within the PESCO mechanism, the European member countries have their own obligations and commitments and must develop common capacities within the mechanism. Within PESCO, two instruments are defining and extremely important in the field of defence (Koppa, 2022): (i) the Coordinated Annual Defence Assessment (CARD), which is administered by the European Defence Agency (EDA) and serves to monitor military spending both at the level of the member states, as well as of the European Union; and (ii) the European Defence Fund (Heuninckx, 2017). Subsequently, by adopting Regulation (EU) 2018/1092, the European Defence Industrial Development Program (EDIP) was created, an industrial program aimed at helping the defence industry in the European Union to improve its capability (Baciu & Doyle, 2019).

The European Union's defence policy and the policy concerning the European Defence Technological and Industrial Base – which aims to reduce the fragmentation of procurement and production activities across Member States are at this time managed by three principal EU organizations (Faleg & Giovannini, 2012; European Union Encyclopedia and Directory, 2024). One of these organizations is the European Union External Action Service (EEAS) (Keukeleire & Delreux, 2022). The EEAS is responsible for developing the common security and defence policy and oversees 13 EU structures that address both civilian and military security issues within the EU. Among its responsibilities is the implementation of the Strategic Compass, a set of objectives aimed at enhancing EU defence by 2030 (Conde et al., 2020). The EEAS also coordinates the European Defence Agency (EDA), an organization under the responsibility of the High Representative of the Union (Muravska, 2014). The EDA acts as a facilitator, particularly in the areas of equipment procurement, training, and technological research and development (Leruth et al., 2022). It identifies areas where the EU's military capabilities could be improved through intergovernmental planning and priority-setting, an effort it has been spearheading since 2017 through studies such as the Capability Development Plan, the Coordinated Annual Review on Defence, and the Long-Term Review. The Directorate-General for Defence Industry and Space (DG-EDIS), a directorate of the European Commission, oversees the industrial components of the common defence policy and its financing, managing the EU's industrial strategy in this area (Rutigliano, 2023). Another key entity is Permanent Structured Cooperation (PESCO), which works to enhance defence research and development among Member States (Conde et al., 2020). Although PESCO collaborates closely with EU members, it is technically not an EU institution, as its secretariat is composed of the EEAS and the EDA. Instead, it is based on a treaty among participating EU members (Ostanina & Tardy, 2024). At this time, PESCO coordinates 68 projects. In principle, these organizations are responsible for various initiatives. Through measures such as those outlined by the European Commission in 2016, studies by the EDA, and more recently, the Strategic Compass, there is a concerted effort to address the long-standing

defence gap (Keukeleire & Delreux, 2022). The EDIS has set new targets, including achieving 35% of intra-community defence trade within the defence market, ensuring that 50% of defence procurement is generated within the EU by 2035, and fostering collaboration among member states to achieve 40% of defence investments. While the objectives and the 2030 deadline are clearly defined, there is no comprehensive execution plan backed by adequate funding. For instance, the EU's 2021-27 budget cycle allocates only €8 billion to the European Defence Fund (EDF), which has been pivotal in financing PESCO projects, to support research and development in the defence sector. Furthermore, new measures are being introduced to attract private sector resources, with the European Investment Bank supporting the defence industry in securing additional funding (Cottarelli and Virgadamo, 2024).

Despite recent improvements, most spending on the military is still done at the national level (Smith et al., 2015). Member States or subsets of Member States take unilateral measures to confirm the continuity of national solutions in the field of defence (in the field of combat aviation there are at least three programs developed simultaneously by MS) (Saulnier, 2020). The military defence industry at European level is mainly based on large national companies, often owned by the state or large national businesses (Leonardo and Fincantieri in Italy, Thales in France and Navantia in Spain). Although at the EU level, there are a number of promoted initiatives (Airbus and MBDA), the military industry still involves a lot of national subcontractors (Briani, 2013).

Member States exhibit highly varied spending patterns, with those closer to Russia understandably incurring higher costs. When compared to Russia alone, the total defence expenditure of the EU is large. However, significant issues arise from the composition and fragmentation of this spending, indicating that the funds are not being used efficiently (European Union Encyclopedia and Directory, 2024). A larger portion of the budget is allocated to personnel remuneration rather than to operations, maintenance, infrastructure, equipment, and facilities. In fact, compared to the US, these resources cost much less per employee. Additionally, European armed forces are not only much smaller in terms of personnel compared to the US military, but they are also less well-equipped. Spending on operations and maintenance, including training, is particularly low, implying that even when equipment is available, troops may not be adequately trained and ready to act. Relative to the overall size of the US and EU economies, the EU's defence production is modest, limiting economies of scale in production, which also affects individual military equipment manufacturers. On the demand side, fragmented procurement processes have led to higher costs and an overabundance of equipment varieties. This fragmentation, along with an over-reliance on national defence companies, further undermines competition and efficiency (Johnson and Turner, 2015). While the EU has set objectives to address these challenges, they are not supported by adequate funding or specific decisions. Given the current level of spending, resolving these issues could lead to significant savings and improved efficiency, particularly through more intensive collaboration. However, much more effort is required to accurately estimate the potential savings from defence cooperation projects. Available estimates, ranging from €25 to €100 billion and are cited in various sources. Unfortunately, significant obstacles can impede European defence coordination, including disparities in language, tactics, funding, training, and the free use of resources, as well as differences in the defence plans and objectives of MS (Calcara et al., 2020). The most significant challenge, however, remains the predominance of national interests. Given the pressing need to enhance defence capabilities, it is hoped that collaborative efforts will now succeed, even if only gradually. While there is a general consensus that improving Europe's defence capabilities will require additional funding, the critical issue of how to secure these funds remains unresolved (Cottarelli and Virgadamo, 2024).

At the level of the MS, a comparative analysis has been carried out to highlight the ability of each MS to achieve the best results with the lowest use of resources. Afterwards, the level of inefficiency for each state in allocating defence expenditures was estimated. If action at EU level proves to be more efficient compared to national, regional or local level, this could provide a rational for supporting EU action (Draghi Report, 2024). In accordance with the principle of subsidiarity, the EU is justified in exercising its powers when Member States are unable to achieve the objectives of a proposed action satisfactorily and added value can be provided if the action is carried out at Union level. A comparison with the American system is desirable and useful in our analysis. At the end of the report, different waste reduction scenarios are presented in the field of defence spending efficiency in the EU.

2. Review of research studies investigating defence spending in Europe

The majority of research in the field of defence economics is based on an examination of how public military expenditures affect the economy as a whole. It is important to recognize the insufficiency of studies that have examined efficiency up to this point (Solana Ibáñez et al., 2020). It is imperative to draw attention to the current challenges in obtaining sufficient input and output data in the military context of the EU27. Analyzing the defence sector, and especially its efficiency in relation to various activities, is a difficult area to explore, the literature being very scarce, mainly due to the lack of sufficient data. However, in the absence of studies in this area, there are a few notable exceptions mentioned below. We draw attention to articles related to productivity in the fields of technology and industrial security.

Hartley (2006) investigates the possibility of creating an industrial defence policy within the EU and shows that increased efficiency can be achieved by minimizing the duplication of expensive research and development, gaining an advantage through trade and competition, and achieving economies of scale. Unit cost reductions of 10% or less were observed for tanks and combat ships, 20% for fighter aircraft, 20% to 30% for conventional munitions, and 25% to 40% for missiles. Price reductions were typically expected to range from a lower value of 10% to an upper value of 20% in a single European market open only to enterprises from member states. Typical cost savings ranged between 15% and 25% when defence enterprises from around the world were allowed to compete in a single European market. These are approximate estimates, and the differences were significant. For example, compared to European equipment, various American weapons (such as aircraft, combat helicopters, armored fighting vehicles, and combat ships) were designed to be 5% to over 40% cheaper. The author finds out that it can be achieved an increase efficiency, with savings for 2003 ranging from approximately $2 billion to over $6 billion annually.

Dominguez et al. (2024) researches the efficiency of public spending for 27 NATO member states in the period 2010-2017 and found, based on the DEA methodology and the Malmquist Index, that most states experienced improvements in efficiency (16, especially those in Western Europe), while a minority decreased (11, especially from Eastern Europe). They examine the relationship between the defence budget and military personnel spending, as well as public perception of security, using a panel data set covering the years 2010-2017. The Data Envelopment Analysis (DEA) methodology uses a series of macroeconomic inputs and a single output related to the effectiveness of NATO member states' military industries. NATO countries show high efficiency rates, averaging around 80% for the period studied, with a growth trend of 2.5%, according to the results obtained. Consequently, the average calculated technological efficiency was approximately 85.3%, meaning that the NATO countries considered could increase their citizens' security by about 14.7% without altering the resources allocated to their defence.

Briani (2013) identifies two primary factors that contribute to the costs associated with the lack of a unified European defence system, commonly referred to as the 'non-Europe' cost in the defence sector. The first factor pertains to the fragmentation of the armed forces across Member States. Despite their frequent deployment in multinational contingents abroad, European armed forces continue to be organized, managed, and financed on a national level. This national-level approach extends to the development, acquisition, and maintenance of weaponry, leading to increased costs in establishing, maintaining, and operating armed forces across Europe. The second factor is the absence of a fully integrated defence market across the continent. Traditionally, the European

common market has informally excluded the defence industry, resulting in 27 separate national defence markets constrained by legal and bureaucratic barriers. This fragmentation hampers the development of the defence industry and the overall military capabilities of the EU. The author estimates that the annual cost of this disjointed approach to defence could be as high as €100 billion; moreover, the political and strategic costs could be even greater, potentially jeopardizing the effectiveness of any future EU foreign policy.

Karamanis (2022) examines the relationship between military spending, investment, and economic growth among the 25 European nations participating in Permanent Structured Cooperation (PESCO). Using a vector autoregressive (PVAR) approach, the author identifies two distinct groups of nations, based on the network links created by defence alliances within PESCO programs. His findings suggest that while military spending can indeed stimulate economic growth, the benefits are not uniformly distributed across Member States. The author argues that these countries could maximize the effectiveness of their defence budgets through increased cooperation within joint initiatives.

In the context of appropriate defence spending, Dorn, Potrafke, and Schlepper (2024) discuss the NATO 2% target. The author's note that while the NATO benchmark – which requires each alliance member to allocate at least 2% of their GDP to defence – implies that increased spending should lead to enhanced defence capacity, other factors such as efficiency in weapon acquisition and the coordination of European partners are equally important. They caution that while reaching the 2% target is a significant step forward, it does not necessarily guarantee the swift or robust development of defence capabilities needed to prevent potential conflicts.

Ballester (2013) highlights the economic inefficiencies of maintaining separate national defence systems across Member States and suggests that the costs associated with national-level defence operations, as opposed to a more integrated European approach, could range between €26 billion and €130 billion annually. The results underscore the potential savings that could be achieved if Member States operated under a more integrated defence framework similar to that of the United States. The 27 Member Sates could achieve the same level of defence effectiveness at a much lower cost if the EU's defence operations were more integrated.

Saulnier (2020) develops a methodology based on DEA to calculate the efficiency of public spending in a number of priority areas for the EU and most importantly calculates waste rates as the amount of spending that can be saved for a certain level of production. In defence, the author finds large inefficiencies due to duplication of military projects, lack of effective competition, and largely unintegrated markets amounting to up to €32 billion in military spending and up to €13 billion in military procurement (25% of the defence budget).

Bertelsmann Stiftung (2017) explored the potential efficiencies that could be gained through enhanced coordination and integration of military capabilities among Member States. The study focused on the concentrated provision of military equipment and the coordination of decision-making processes across different national forces. Evidence from the research indicates that larger military forces tend to have a higher proportion of personnel who are deployed and sustainable in terms of capabilities, with this proportion increasing in line with the total number of soldiers in the land forces. This trend is particularly notable in the largest European armies, such as those of France, Greece, Spain, and the United Kingdom, which significantly influence these findings. However, when these larger armies are excluded from the analysis, the positive correlation between force size and deployability becomes much less apparent. This suggests that the economies of scale observed in larger forces may not be as straightforward when applied across the board. Bertelsmann Stiftung's

research further examined potential cost reductions in the provision of land forces across Europe. The study estimated that fulfilling the NATO tasks, MS would require between 480 000 and 750 000 soldiers, considerably fewer than the 890 000 at this time stationed across 28 different national armies. The authors identified significant potential cost savings, depending on the salary structure assumed, with estimated savings ranging from €3.1 billionto over €9.2 billion. Additionally, the research suggested that continued collaboration and cooperation in military procurement could lead to further cost reductions.

The European Parliament (2015) estimated that better coordination in procurement could yield annual efficiency savings of approximately €12 billion. These findings collectively highlight the potential for significant cost savings through improved coordination and integration of military resources across Member States.

3. Data and methodology used

Most of the existing researches up to this moment regarding the policies in the field of defence rather assume theoretical discussions starting from some general normative principles. In the present study, we use a new approach to analyze this issue starting from the notions of efficiency and waste. Our methodology is in accordance with the one previously used by Saulnier (2020), which starts from the idea of Cost of NonEurope. The methodology involves the calculation of the amount of resources that would have remained available to the Member States if a certain policy had been implemented at the European level. As an empirical methodology, Data Envelopment Analysis (DEA) is used to calculate efficiency, inefficiency and then waste (Banker et al., 2013).

3.1. Data Envelopment Analysis

In economics, Data Envelopment Analysis (DEA) is a widely used method for calculating efficiency and which was developed by Charnes, Barnes (1984). The basic idea of DEA is finding a 'production frontier', which is economically efficient, for a series of units (DMU), starting from a series of input and output data. MS that are found on the production frontier are considered efficient, and those that are not found are considered inefficient. Following the DEA analysis, each MS receives an efficiency score that can vary between 0 (minimum efficient) and 1 (maximum efficient). After calculating the efficiency, 'waste' is calculated (the inputs that could have been saved if all the units had produced the same total volume of outputs) (Saulnier, 2020). The data for input are those that assume the resources allocated in the budgets of the MS for the generation of the respective public good. The output data assume either the general results of public services (defence, health, education) or more targeted results that assume the intermediate production necessary for the provision of these public goods.

The DEA methodology knows two types of approach: constant return of scale (in which the analyzed variables are considered CRS constants) and variable Variable Returns to Scale (the analyzed indicators are considered VRS variables). In our analysis, we use the DEA model with the Variable Returns to Scale (VRS) specification to identify the types of returns to scale that best describe the production function for each MS (Saulnier, 2020). Another very important notion that appears in the DEA analysis is given by the returns to scale, which can be constant, increasing or decresing. The basic idea of our analysis is that by being able to directly calculate these two characteristics: efficiency and obtaining increasing returns to scale, efficiency can be improved through the appropriate use of shared spending at the European level and through the debate on common political action at EU level. Like any other technique, DEA assumes some limits, especially generated by the availability and comparability of data for the 27 MS. Consequently, in order to perform a proper analysis of the causal relationship between inputs and outputs, we complement our primary analysis with a comprehensive set of robustness exercises that use various definitions of inputs and outputs, as well as other methodologies (scenarios for estimating waste reduction under different assumptions, using mainly regression techniques).

In order to analyze the efficiency of public defence spending, the study involves the following steps (Saulnier, 2020):

1. Comparison of Member States to find the frontier of efficiency in the two military policy issues: troops deployment and procurement expenditure;

2. Identifying ways in which EU actions could bring all member states closer to the efficiency frontier.

The DEA methodology involves the comparative analysis of how either different member states that spend the same amount of money have different results, or obtain the same result, but spend different amounts of public money. In this way, MS are identified through the prism of efficiency in 'more' or 'less' efficient. There are two possibilities to estimated the efficiency scores: input oriented (achieving the highest results for a given level of input) or output oriented (using the minimum input to achieve a given result).

The efficiency frontier is made up of the nations that offer the best trade-off between output and expenditure, characterized by the fact that no other nation spends the same amount of money to achieve the same output or to reach a higher level of output. This could be seen as a EU efficiency frontier, and the amount of waste is determined by how far each MS is from it (Saulnier, 2020). 'Efficiency scores' are used to quantify this difference; a score of 1 indicates that a country is 'on the efficiency frontier' or efficient compared to other member states. Coordinating and harmonizing policies at EU level enables the common 'EU production frontier'. In this way, the rate of budgetary 'waste' for member states operating below the production frontier is defined by identifying benchmarks operating at the production set frontier, based on the assumption that EU will be able to move each MS to the production frontier through the role its policy coordination and harmonization.

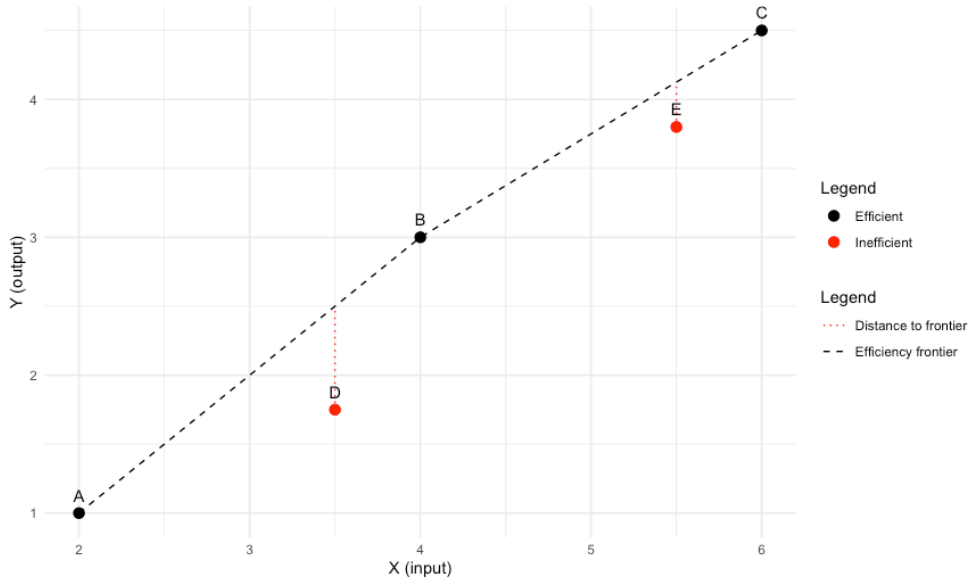
In particular, this demonstrates how important it is to define the inputs and outputs to be considered in the empirical applications that follow before applying the methodology.

Figure 1 shows an illustration of the intuitive principles of the DEA methodology (Afonso & Kazemi, 2017). The horizontal axis represents the level of public spending as consumed input, and the vertical axis the level of the achieved result. Calculation units (MS) are represented by dots; with the help of these units, the efficiency frontier is established; points A-F are represented by dots and the proximity or distance from the efficiency line indicates the efficiency obtained by the MS. MSs that are on the efficiency line are the most productive production units; assuming a better balance between public expenditure and desired outcomes. This is because no other decision-making unit can achieve the same level of output with less input or a higher level of output with the same amount of money spent. To put it more broadly, the EU 'frontier' is where those effective MSs (A, B and C), or linear combinations of these effective MSs, are located that lead to the maximum level of output (Saulnier, 2020).

Units that are not on the efficiency line (below it) are unsuccessful because an efficient unit or linear combination of efficient units dominates them. These units use a higher level of input than the other units to achieve the same amount of output; as a result, they are inefficient and waste money in this way compared to the EU 'frontier'.

The inputs of the model assume either the public expenditure on defence per capita in the case of the first model, or the expenditure on defence procurement in the case of the second model, and the results of the model start from the anticipated effects of defence expenditure and assume either the number of deployed troops, or R&D expenditures.

Figure 1 – Example of an efficiency frontier



Source: Authors representation.

The relative distance between the two DMUs and the EU border determines the degree of inefficiency by determining the deviation of the DEA score from 1 (1 minus the DEA score). The DEA estimate establishes for each unit (MS) an average efficiency score θ. Starting from θ estimated by the DEA method, waste can be calculated for each unit as the difference: waste = (1- θ) x input. The input is calculated as the average level of defence spending for the entire analysis period, 2005-2022.

3.2. DEA in defence sector

Within the literature on efficiency, Data Envelopment Analysis (DEA) is a well-respected non-parametric technique for efficiency analyses that can be used in the absence of market price information. Previous research on efficiency and productivity (DEA) in the defence has only analyzed support activities, such as maintenance and recruitment (Hanson, 2016). However, the main fields of defence, personnel and equipment, has not been examined in the literature. Since the pioneering work of Lewin and Morey (1981) and Charnes et al. (1984), the field has not advanced significantly towards practical military applications.

The lack of research could be due to at least three factors (Hanson, 2016): a) challenges in estimating and measuring military output; b) variability resulting from the small number of military units; and c) limited information on the effectiveness of operational units. The most difficult problem to solve is probably modeling the production process and the output of the defence forces, which is also the most significant. Recognizing that defence markets do not have market values for military output, Hartley (2010, 2012) implicitly defines them as squadrons of aircraft, submarines, or tank forces. He also noted that most published research that has calculated military production functions has done so using a cost-efficiency approach. The limited number of observations generated is the second reason for the lack of studies on operational units. The reason is that most armed forces have a limited need for homogeneous units with no need or the means to duplicate armed forces on a significant scale. As a result, research on the efficiency of defence units is limited to small number.

The military is interested in productivity and efficiency studies because they can provide possible standards. Including more countries in the research could significantly increase the amount of data already available. However, there are usually few opportunities to collect an extensive data set that includes information from multiple countries, and data sources on the performance of operational units are usually limited. In addition, a broader investigation is hampered by variations in standards and training requirements across countries. A third explanation for the lack of studies could be data restrictions and national heterogeneity.

The first applications of DEA in the defence industry date back to the early 1980s, when Charnes et al. (1984) and Lewin and Morey (1981) conducted research on aircraft maintenance units and their recruitment. It is noteworthy that, although the military was initially presented as a new and promising subject for DEA research, forty years later there are still no large applications to all defence areas (Hanson, 2016). According to the literature, the method used by Charnes et al. (1984) is the best illustration of how to measure efficiency in operational units—the main enterprise of the armed forces. The limited samples of military units that need to be investigated represent another problem in the defence industry. Small sample sizes lead to few observations and reduced degrees of freedom in models.

One thing all these studies have in common is that they lack operational data. Although conducted in a military environment, the project duration, signed contracts, and transaction volume are not all specifically related to military operations. Given that there are currently no succinct terms used in the military field to describe achievements and outcomes, the researcher must first correctly define the measures to focus our research on the idea of efficiency rather than effectiveness. In general, public service activities can be divided into two categories: first, there are the services that are provided using the resources made available by the relevant state institution or agency (Hanson, 2016).

Historically, the military industry has used the method of national accounting, which defines outputs as equivalent to inputs in terms of costs. On the other hand, the body of research on the idea of output and outcome in defence is growing. According to Hartley (2012), defence outputs are a complicated collection of factors related to safety, peace, stability, risk management, and the avoidance of dangers and conflicts. Additionally, the terms squadrons of aircraft, submarine forces, and tank forces are also used to describe defence outcomes (Hartley, 2012). The concept of readiness has the potential to define, at least partially, the performance of a military unit. Peace and security are considered high-level outcomes and are difficult to quantify.

Two potential indicators of capability are identified: one for personnel and one for equipment. Both measures would have a quantitative and a qualitative component. Rank, grade, balance of force levels with readiness, and peak force points are the recommended qualitative improvements for the workforce. It is recommended that equipment be subject to both a readiness measure and an explicit quality adjustment that accounts for quality variations over time. Outputs are further separated into two categories: direct and indirect.

The military has significant potential for building qualitative and quantitative indices (Hanson, 2016). Depending on the type of unit, branch, and country, several measures can be implemented. The level of expertise is usually measured as part of the quality measure, while an index for the necessary personnel and equipment usually constitutes the quantity measure. Force multipliers are a concept frequently used in military literature. According to Hurley (2005), the idea is as simple as recognizing that the elements used in a military production function have positive interactions with each other. In a military production function, for example, where the two variables are soldiers and armament,

the two variables complement each other. The force is greater when it comes from a combination of people and armament than from either alone.

One way to simplify the relationship between capabilities and outcomes would be to construct an expression for capacity production (also known as the production function of intermediate outcomes) as a function of a single production unit by aggregating unit-level outcomes.

The dimensionality of a DEA model is constrained by aggregation, in addition to certain desired characteristics in modeling a single production unit. The findings from our literature analysis on DEA in the military field further support our belief that observations are lacking in the defence industry, which poses a challenge for studies in this field. Given the minimum number of military units, the above discussion raises the possibility of aggregation as a potential remedy.

3.3. Data and methodological approach

All 27 Member States were initially selected. The analysis period was the longest for which data are available, 2005–2022, divided into four periods, corresponding to important events for the military field: 2005–2013 (prior to the annexation of Crimea), 2014–2016 (after the annexation of Crimea), 2017–2021 (formulation of commitments at EU level and development of PESCO), 2022 (war in Ukraine). Also, the entire period was taken into consideration. The data source for the analysis was the European Defence Agency (EDA), NATO, Eurostat, Stockholm International Peace Research Institute (SIPRI), public sources (National Ministries of Defence) with comparable data.

The Ministries of Defence from the 27 member states of the Agency annually provide defence statistics to the European Defence Agency (EDA). EDA is responsible for maintaining these statistics and publishes the totals in its annual defence statistics reports. Important indicators such as total defence spending, defence investments, joint investments, and research and technology spending are available in EDA's defence statistical reports. The European Defence Agency's database is the source of information regarding the benefits of collaborative procurement in the EU.

Another important source for the data used in this paper is the NATO database. The standards of this database allow users to more accurately estimate the expenditures that affect the defence capabilities of EU members. Items that are specifically related to defence capabilities are sometimes excluded from the national definitions that report credits to the Ministry of Defence, while items primarily related to national border defence are included. NATO relies on data provided by EU members, who then record defence budget figures in accordance with the ESA 2010 manual.

For countries that are not at this time NATO members or were not members in the period under consideration, SIPRI data are used. Additionally, SIPRI is the source for statistics on arms trade from the arms trade database and for data on international arms transfers from the arms transfers database. Transactions are expressed in trend indicator values rather than U.S. dollars. The European External Action Service database is the source of information regarding the value of European arms exports in 2023.

The International Monetary Fund's World Economic Outlook 2024 contains figures on GDP and GDP per capita in U.S. dollars for the U.S. and the EU. Therefore, there are no significant differences between our calculations of the spending-to-GDP ratio and the figures provided by NATO. The reported ratios are generally comparable and consistent.

The Eurostat database is the source of information on the EU population in 2023 and the R&D defence expenditure in Europe.

In cases where indicators for certain periods of time, usually short, do not have data for all years, we consulted the annual activity reports of the Ministry of Defence from those states in these isolated and few cases. For other cases, like Germany and Denmark, with missing values for deployment, defence procurement expenditure and/or collaborative procurement, the NATO database is used for finding appropriate proxy values.

Table 1 – Variable description and data sources

Variable	Description	Data source	Usage
Defence expenditure per capita	It includes the total sums used in the defence sector (salaries for personnel in the armed forces and the civilian sector, infrastructure, aid, procurement, operations and maintenance, as well as military research and development). The currency used to express this data is the euro (constant prices base year 2015).	EDA, NATO	Model 1
Deployed troops per million inhabitants	Armed forces that can be deployed in a short period of time to other nations or territories abroad. A 'deployed' force is one that is stationed permanently or for a period of more than six months.	EDA, NATO,National Ministries of Defence	Model 1
Defence procurement expenditure	Public procurement in the defence sector or the acquisition of weapons and other defence equipment. The currency used to express this data is the euro (constant prices base year 2015).	EDA, NATO	Model 2
Defence R&D expenditure	Expenditures directly incurred by the state or enterprise during the creation, design, and improvement of its goods, services, technology, or procedures in the defence sector. The currency used to express this data is the euro (constant prices base year 2015).	EDA, EUROSTAT, NATO	Model 2
ECFR index	An index developed by the ECFR and composed of six sub-indices; the defence index assesses the capacity of Europeans to maintain peace and security both within their own borders and beyond, defining their sovereignty in matters of security and defence. The index examines territorial defence and crisis management, as well as the capabilities and commitments of countries in both areas. To evaluate the capabilities of countries, the index assesses defence spending, troops deployed in joint missions and operations, membership in and contributions to military alliances and permanent multinational forces, industrial cooperation, and military equipment. Values range from 0 (weak) to 10 (strong).	ECFR	Model 3
Employment in defence industry	Total number of persons working in sectors directly associated with the production, development, and maintenance of military equipment, facilities, and services.	SIPRI	Model 4
Turnover of defence industry	Total revenue generated by companies and organizations within the defence sector over a specified period, typically a fiscal year. This includes income from the production and sale of defence-related goods and services, such as military equipment, support and maintenance services, technology systems, and consultancy.	SIPRI	Model 4
Stock of equipment	Land weaponry (total number of battle tanks, armored vehicles, artillery weapons, IFV, anti-tank); Air weaponry (fighter attack aircrafts, attack helicopters, air defence systems, UAV, utility aircrafts, utility helicopters); Sea weaponry (aircraft carriers, attack submarines, corvettes, destroyers, frigates)	SIPRI	Model 5

Source: Authors' compilation.

For the calculation of the efficiency and subsequent inefficiency of public defence spending, two models were used, previously developed by Saulnier (2020) and which have shown their applicability in defence. The DEA method involves the comparison of analysis units starting from a series of input data, as well as output data. The choice of input and output data is the most important step in DEA analysis.

The analysis is inherently difficult since it is done in the field of defence, which is a 'pure public good' (Hartley, 2006). Consequently, defence does not have established indicators for results and this is a consequence of which there are extremely few studies in the specialized literature regarding efficiency in the field, each using distinct indicators. The most suitable result for defence, the presence of peace, implies, especially in the last period, an extremely high variability. Thus, this indicator cannot be used as a measure for results, especially in a comparative analysis, considering that most of the member states are part of NATO and the EU, and they have maintained peace for all member states (EDA, 2020). The evaluation in the defence sector, however, requires the appropriate combination of several indirect result indicators that include both personnel and military equipment. Under these conditions, we use two models to analyze the effectiveness of military spending (Saulnier, 2020):

- Model 1 which uses as input defence expenditures per capita and as output deployed troops per million inhabitants;
- Model 2 which uses defence procurement expenditures as input and research & technology expenditures as output.

Table 2 – DEA models specification

	Input	Output		Input	Output
Model 1	Defence expenditure per capita	Deployed troops per million inhabitants	Model 3 (robustness model 1)	Defence expenditure per capita	ECFR index
Model 2	Defence procurement expenditure	Defence R&D expenditure	Model 4 (robustness model 2)	Defence procurement expenditure	Employment & turnover in defence industry
			Model 5 (robustness model 2)	Defence procurement expenditure	Type of equipment (stock of weaponry: land, air and naval)

Source: Authors summation.

The efficiency models

The defence efficiency analysis employed in this study aims at evaluating, for a selected outputs of the defence industry and their corresponding inputs, the efficiency of the EU member countries, i.e. how close each country is to being efficient relative to the best performers in the group.

We selected five outputs of the defence industry:

1. The number of deployed troops per million inhabitants (model 1)
2. The R&D defence expenditure (model 2)

3. The ECFR defence index (model 3, as a robustness for model 1)
4. The employment in defence industry & Turnover in defence industry (model 4, as a robustness for model 2)
5. The stock for each type of equipment – land, air and naval (models 5a, 5b and 5c, as a robustness for model 2)

Each output reflects a different aspect of the defence industry's performance and impact, thereby providing a comprehensive view of its efficiency. We present a justification of their relevance in measuring the results of the defence industry.

Model 1: The Deployed Troops per million inhabitants

The number of deployed troops is a direct indicator of a country's military operational capability. It reflects the readiness and ability of the defence sector to project power and maintain security. Deploying troops involves significant logistical, training, and support resources. Measuring this as an output helps to assess how effectively a country utilizes its defence budget and resources to maintain and deploy its forces. The presence of deployed troops can also be a measure of strategic impact and influence, both regionally and globally.

Model 2: The R&D Defence Expenditure

R&D expenditure is crucial for developing new technologies and maintaining a technological edge in defence. It reflects a commitment to innovation and the future capabilities of the defence sector. Investment in R&D can lead to advancements in defence technologies, which are critical for long-term national security and strategic superiority. R&D in defence can have broader economic impacts, spurring innovation and technological advancements that benefit other sectors.

Robustness check models

Model 3: The ECFR Defence Index

The European Council on Foreign Relations (ECFR) defence index is a composite measure that includes various factors such as military capability, readiness, and strategic alignment. Using this index as an output provides a holistic assessment of a country's defence efficiency. The ECFR index allows for benchmarking against other countries, providing a relative measure of defence efficiency and effectiveness. This index reflects policy outcomes and strategic effectiveness, making it an appropriate measure for evaluating the efficiency of defence policies and expenditures.

Model 4: The Employment in Defence Industry & Turnover in Defence Industry

Employment in the defence industry highlights the sector's role in job creation and its contribution to the overall economy. It reflects the labour intensity and the human capital investment in the defence sector. Combining employment and turnover provides a more nuanced view of efficiency. It captures both the economic output (turnover) and the social impact (employment), offering a balanced assessment of how effectively resources are utilized. This combination helps to evaluate the sustainability and resilience of the defence industry by looking at both financial performance and employment stability.

Model 5: The stock for each type of equipment

The stock of weaponry encompasses a wide range of assets, including tanks, aircraft, ships, and other vital military equipment. This measure provides a direct quantification of a nation's defence capabilities, reflecting its ability to defend itself and project power, being an indicator of

preparedness and readiness. Monitoring the stock of weaponry helps in assessing how effectively financial resources are being converted into strategic assets. It provides insights into the efficiency of procurement processes and the management of defence resources. The ability to support allies with military assets is a significant aspect of international relations. Countries often leverage their military capabilities to strengthen alliances and extend their influence globally.

Each model highlights different dimensions of defence efficiency, from operational and strategic capabilities to economic and innovation impacts. By using multiple outputs, these models provide a comprehensive evaluation of the defence sector, ensuring that all significant aspects of performance are considered. The chosen outputs align with key policy goals and priorities in defence, such as readiness, technological advancement, economic impact, and strategic positioning. Using these wide-ranging outputs in DEA models allows for a robust analysis of the defence sector's efficiency, capturing the multidimensional nature of defence operations and their impacts. This approach ensures that the assessment is balanced and provides valuable insights for policy-making and strategic planning.

Scenarios for estimating waste reduction

Projections of waste reduction under scenarios assuming different conditions were made, using time series data covering the period 2005-2022, to observe how different percentage increases in troops deployment and in European collaborative procurement ratio impact the waste.

To calculate the waste, we used the efficiency scores from the DEA models 1 and 2 as follows (Saulnier, 2020):

1. Calculate the efficient input: For each country in each year, calculate the efficient input level. The efficient input level is determined by multiplying the observed input by the efficiency score.

   $Efficient\ Input = Efficiency\ Score * Observed\ Input$

2. Calculate waste: The waste is the difference between the observed input and the efficient input. This can be calculated as follows:

   $Waste = Observed\ Input - Efficient\ Input$

The calculated waste gives an understanding of the inefficiency in defence and procurement expenditures. To estimate the reduction in waste when increasing the deployment and the collaborative procurement, regression models were estimated, using the waste as dependent variable.

Since the regression variables were not stationary and the estimated waste values have to capture the difference in waste when variating the deployment and the collaborative procurement ratio, the variables are used in the form of the first difference.

The time series regression model with differenced values has the following functional form:

$$\Delta Waste_t = \beta \cdot \Delta Ratio_t + \epsilon_t \ ,$$

where:

$\Delta Waste_t = Waste_t - Waste_{t-1}$ (the change in waste from one period to the next),

$\Delta Ratio_t = Ratio_t - Ratio_{t-1}$ (the change in deployed or collaborative ratio from one period to the next)

β is the estimated coefficient for the *Ratio* variable, indicating, on average, the estimated decrease in waste for each 1% increase in deployed or collaborative ratio.

The independent variables are measures for military capacity and collaborative procurement ratio. The measure for military capability is different from the one used in the DEA model, to avoid circular reasoning, since the output variable in the DEA model (deployed troops per million inhabitants) is already part of the calculation of the dependent variable (waste). The independent variable used in the regression model for estimating waste reduction is deployed troops as percentage of total armed forces, a variable that measures military capability but it is not directly tied to the calculation of the efficiency scores and the resulting waste.

4. Defence spending efficiency analysis for the European Member States

4.1. Defence spending efficiency analysis for the EU military operational capability

All 27 Member States were initially selected. The analysis period was the longest for which data are available, 2005–2022. The analysis period was divided into four periods, corresponding to important events for the military field: 2005–2013 (prior to the annexation of Crimea), 2014–2016 (after the annexation of Crimea), 2017–2021 (formulation of commitments at EU level and development of PESCO), 2022 (war in Ukraine). Also, the entire period was taken into consideration. The data source for the analysis was EDA, NATO and Eurostat, i.e. public sources with comparable data.

Model 1

Input	Total defence expenditure (per capita)
Output	Number of deployed troops per million inhabitants

The input indicator, the defence expenditures per capita, includes all expenditures made by a state for its armed forces, regardless of whether they are current or capital. For the comparability, the total of these expenditures is divided by the population of the respective state. It is expected that the higher the level of spending, the better its military strength. It should be noted that in this long period there were two successive commitments to increase defence spending NATO (2004) and EU (2017), which most of the Member States tried to progressively achieve.

The output indicator, the number of deployed troops per million inhabitants, shows the number of military personnel that can be quickly deployed by a state. For the calculation of the efficiency of military expenditures, it is mandatory to use this indicator, because the military personnel is an integral part of the military capacity (personal force ready to fight) (Saulnier, 2020). The increased 'production' of military personnel implies the simultaneous development of the military capacity as a whole. This indicator, deployed troops, is also proof of the increase in the efficiency of defence programs, measuring the performance of a state's defence system. Maintaining a strong army and ready to intervene at any moment shows the involvement of the respective state in the military field, being also a result of the possibility of projecting its military power.

The initial analysis considered all 27 Member States. But the results generated by DEA are often susceptible to errors for variable selection, and especially if there are outliers among the countries. Given that it was made the estimation with all the 27 states, two states, Cyprus, and Malta, were highlighted as outliers. Under these conditions, as a measure to mitigate the impact of these values on the analysis, we decided to eliminate these states from the analysis.

We estimate DEA scores for all 4 analysis periods, and then for the entire period, for all 25 MS. The results are presented in Table 3. The most efficient country is France, with scores of 1 for all periods. Other countries, like Bulgaria and Italy, have also obtained in certain periods scores of 1. In principle, in the case of the four periods, the situation of the average scores for MS remains in the same coordinates. Larger EU states with greater resources and a larger army also show higher efficiency. The average of the efficiency scores for all 25 EU states in the period 2005–2022 is 0.508. This value shows that for these MS, there is enough room for improvement through a defence policy at European level.

Table 3 – Efficiency scores for Model 1 for Member States, period 2005 - 2022

		2005-2013	2014-2016	2017-2021	2022	2005-2022
	Country	Eff. score	Eff. score	Eff. score	Eff. score	Eff. score
1	Austria	0.290	0.384	0.497	0.404	0.369
2	Belgium	0.216	0.310	0.393	0.257	0.283
3	Bulgaria	0.963	1.000	0.867	0.728	0.929
4	Croatia	0.552	0.585	0.612	0.422	0.567
5	Czechia	0.455	0.543	0.564	0.402	0.497
6	Denmark	0.126	0.139	0.196	0.201	0.152
7	Estonia	0.426	0.255	0.301	0.228	0.352
8	Finland	0.168	0.156	0.206	0.146	0.175
9	France	1.000	1.000	1.000	1.000	1.000
10	Germany	0.504	0.548	0.454	0.374	0.490
11	Greece	0.178	0.214	0.334	0.227	0.230
12	Hungary	0.754	0.909	0.818	0.493	0.783
13	Ireland	0.383	0.447	0.687	0.674	0.494
14	Italy	0.896	1.000	0.857	0.606	0.886
15	Latvia	0.744	0.592	0.400	0.312	0.599
16	Lithuania	0.904	0.569	0.401	0.257	0.672
17	Luxembourg	0.231	0.221	0.239	0.186	0.229
18	Netherlands	0.209	0.231	0.239	0.236	0.223
19	Poland	0.812	0.405	0.779	0.398	0.712
20	Portugal	0.332	0.371	0.486	0.445	0.388
21	Romania	1.000	0.850	0.710	0.517	0.868
22	Slovakia	0.539	0.528	0.519	0.399	0.524
23	Slovenia	0.340	0.456	0.548	0.402	0.420
24	Spain	0.579	0.706	0.777	0.650	0.659
25	Sweden	0.177	0.179	0.265	0.182	0.202
	Average*	0.511	0.503	0.525	0.405	0.508

* Simple averages were calculated for the efficiency scores.

Note: Malta and Cyprus are outliers and excluded from the analysis.

Source: Authors' calculation.

To calculate inefficiency, waste is estimated separately for each MS according to the formula: *(1-efficiency score) x real input* (represented by the total defence expenditures, in the period 2005-2022). Estimated separately for each member state, it is represented in column 5 of Table 4. One country, France, do not present waste, being efficient from the point of view of deployed troops, having the largest number of deployed troops. However, the total estimated waste at the EU level between 2005-2022 is over €45.3 billion.

The country with the highest estimated waste is a large country, Germany; the result can be explained by the fact that, although there are large allocations for defence expenditures, the number of German deployed troops is small compared to other countries. Large states show comparative or even lower estimated waste than some medium-sized states (Italy 2.54; Spain 3.82), being rather efficient compared to other MS, showing once again the importance of scale effects. Average states show high levels of waste: Belgium 3.01; Denmark 2.91; Finland 2.56; Greece 3.9, Netherlands 6.95; Poland 2.35, Sweden 3.83. The fact that these states often have higher inefficiencies than large states shows that they have not yet reached their potential for scale effects. Small states (Bulgaria, Croatia, Latvia, Lithuania, Slovenia) show levels of small waste, if we compare with the fact that they do not even have serious resources allocated to defence.

The last column in the table shows the level of return to scale in the production function using the DEA-VRS model. To determine the type of return to scale, both CRS and VRS DEA models are estimated. If the CRS score is equal to the VRS score, the country is operating at constant return to scale. If the VRS score is higher than the CRS score, the country is experiencing an increased return of scale. Apart from France, the other 24 MS show increasing returns to scale.

These findings can show that by developing coordinated policies at the EU level in the field of defence, it is possible to achieve greater returns of scale and increased military efficiency for the MS.

Table 4 – The estimated waste for Model 1 for Member States, period 2005-2022

	Country	Eff. score	Inefficiency	Total Defence Expenditure (average million €)	Estimated waste value (million €)	Type of return to scale
1	Austria	0.369	0.631	2642.076	1666.338	increase return to scale
2	Belgium	0.283	0.717	4199.893	3011.394	increase return to scale
3	Bulgaria	0.929	0.071	793.488	56.09797	increase return to scale
4	Croatia	0.567	0.433	729.418	315.7193	increase return to scale
5	Czechia	0.497	0.503	2156.33	1084.553	increase return to scale
6	Denmark	0.152	0.848	3440.477	2917.774	increase return to scale
7	Estonia	0.352	0.648	401.504	260.3509	increase return to scale

	Country	Eff. score	Inefficiency	Total Defence Expenditure (average million €)	Estimated waste value (million €)	Type of return to scale
8	Finland	0.175	0.825	3115.98	2569.803	increase return to scale
9	France	1.000	0.000	42272.638	0	constant return to scale
10	Germany	0.490	0.510	38516.145	19628.24	increase return to scale
11	Greece	0.230	0.770	5072.584	3905.913	increase return to scale
12	Hungary	0.783	0.217	1418.881	307.5504	increase return to scale
13	Ireland	0.494	0.506	955.778	483.188	increase return to scale
14	Italy	0.886	0.114	22322.136	2542.109	increase return to scale
15	Latvia	0.599	0.401	381.909	153.0959	increase return to scale
16	Lithuania	0.672	0.328	568.128	186.2138	increase return to scale
17	Luxembourg	0.229	0.771	240.121	185.0815	increase return to scale
18	Netherlands	0.223	0.777	8941.383	6950.264	increase return to scale
19	Poland	0.712	0.288	8174.027	2355.642	increase return to scale
20	Portugal	0.388	0.612	2699.306	1651.597	increase return to scale
21	Romania	0.868	0.132	2664.347	352.6799	constant return to scale
22	Slovakia	0.524	0.476	1064.291	506.8446	increase return to scale
23	Slovenia	0.420	0.580	490.243	284.1552	increase return to scale
24	Spain	0.659	0.341	11211.042	3822.952	increase return to scale
25	Sweden	0.202	0.798	4804.708	3833.453	increase return to scale
	Average	0.508	0.492	Total EU25	45301	

Note: Malta and Cyprus are outliers and excluded from the analysis.

Source: Authors' calculation.

Robustness check for model 1

Model 3

Input Total defence expenditure (per capita)

Output The ECFR Defence Index

To test the robustness of the previously used model, we change the output, deployed troops per million inhabitants, by choosing a new one, the European Council on Foreign Relations (ECFR) defence index, using 2022 data. The ECFR defence index is a composite measure that includes various factors such as military capability, readiness, and strategic alignment. Using this index as an output provides a comprehensive assessment of a country's defence efficiency and a relative measure of defence efficiency and effectiveness. This index reflects policy evaluation as outcomes and strategic effectiveness, making it an appropriate measure for evaluating the efficiency of defence policies and expenditures. The examination encompasses not just contributions made within the EU framework but also additional initiatives that enable Europeans to collaborate in order to improve their ability to act. To generate an overall score for the EU on the six domains, the index takes into account the results of the 27 Member States. Additionally, it separates the nations into four categories that correspond to the different roles that each one plays in the EU's initiatives to strengthen European sovereignty.

Table 5 – Efficiency scores for Model 3 for Member States (robustness check) (EU27, EU25)*

	Country (EU27)	Efficiency score		Country (EU25)	Efficiency score
1	Austria	0.524	1	Austria	0.524
2	Belgium	0.798	2	Belgium	0.798
3	Bulgaria	1	3	Bulgaria	1
4	Croatia	0.584	4	Croatia	0.584
5	Cyprus	0.371	5	Cyprus	0.371
6	Czechia	0.732	6	Czechia	0.732
7	Denmark	0.319	7	Denmark	0.319
8	Estonia	0.513	8	Estonia	0.513
9	Finland	0.272	9	Finland	0.272
10	France	1	10	France	1
11	Germany	0.723	11	Germany	0.723
12	Greece	0.492	12	Greece	0.492
13	Hungary	0.533	13	Hungary	0.581
14	Ireland	0.600			
15	Italy	0.959	14	Italy	0.959

	Country (EU27)	Efficiency score		Country (EU25)	Efficiency score
16	Latvia	0.463	15	Latvia	0.463
17	Lithuania	0.447	16	Lithuania	0.447
18	Luxembourg	0.310	17	Luxembourg	0.310
19	Malta	1			
20	Netherlands	0.748	18	Netherlands	0.748
21	Poland	0.780	19	Poland	0.780
22	Portugal	0.861	20	Portugal	0.861
23	Romania	0.927	21	Romania	0.927
24	Slovakia	0.501	22	Slovakia	0.516
25	Slovenia	0.783	23	Slovenia	0.783
26	Spain	1	24	Spain	1
27	Sweden	0.292	25	Sweden	0.292
	Average	0.64			0.63

*Note: EU27 means that the analysis was carried out with outliers, EU25 means that the analysis was carried out without outliers.

Source: Authors' calculation.

As can be seen from Table 5, the results are similar to those obtained previously. The countries with the highest score are France, Romania, Spain, Italy; large states show higher efficiency scores than small states, showing once again the potential of scale effects.

4.2. Defence spending efficiency analysis for the EU procurement and Research & Development (R&D)

Model 2 developed in this study starts from the theoretical formulation developed by Saulnier (2020). The theoretical foundation involves the consideration of a production function that starts from the premise that the investments made in the purchase of equipment by the army (procurement defence equipment) will generate in the future the development of better and more technologically sophisticated equipment.

Model 2

Input Equipment procurement expenditure

Output R&D expenditure in defence industry

The quality of future military equipment is a reasonable outcome measure for defence, as it is obvious that the degree of defence provided depends on the technological sophistication of the military hardware. In the literature (Hartley, 2020), it is specified that the current research and

development in the field of defence positively influences the quality of future equipment, thus having a strong impact on the final result of defence. Thus, we start from this premise that the current level of R&D expenditures can be considered as a substitute for the future quality of future equipment. Under these conditions, we use defence equipment procurement expenditures as an input, which stimulates research and development in the field of defence (intermediate production), ultimately influencing the quality of military hardware (the result). Previous studies in the literature (Saunier 2020) have shown that the purchase of defence equipment is a strong predictor of research and development expenditures in the field, having an impact that lasts for a long period of up to 4 years.

The methodology used to make the estimates allows the comparative evaluation of the states to highlight the potential efficiency gains from the implementation of the EU's spending in defence. Apart from the previous section related to the human capabilities of the defence (deployable troops), an analysis must also be carried out to study the technical capabilities of the defence (military hardware - equipment). As the input variable, starting from the previous theoretical discussion, we use the expenditures for the purchase of military equipment, and as the output the R&D expenditures for defence, a good indicator of future military equipments. At the EU27 level, military procurement expenditures assume an impressive amount of 500,226 billion €, with the biggest buyers being France and Germany (over 100 billion €). Large states spend the most for the procurement of military equipment (France, Germany, Italy, Spain), as well as medium-sized states (Poland, Romania, Sweden). It should be noted that most of the EU27 states had expenditures of over 1 billion each during the period, with the exception of small states (Cyprus, Malta and Slovenia).

Defence R&D expenditures assume a total of €106 billion, with the largest contributors being France (over €77 billion) and Germany (over €21 billion). In this case, only a small category of states allocates sums for military R&D expenditures at a significant level of over €1 billion (Italy, Netherlands, Poland, Spain and Sweden). The rest of the EU states do not allocate significant amounts for this indicator, many of them having values even below 100 million €.

Table 6 shows the results obtained by applying model 2. The input and output variables are expressed in €, specifying that 2015 is used as the base year for converting data into constant prices for nominal values. The data sources for the analysis are EDA and Eurostat, and the analyzed period is 2005-2022. Due to insufficient allocations and the fact that there is the possibility of appearing as outliers, three states (Cyprus, Ireland and Malta) were eliminated from the analysis. For the analysis, only one variable is used for each indicator, considered as the average value of the period. As can be seen in table 5.4, there are two efficient countries for this model: France and Slovenia. The average efficiency of the Member States is 0.558 for the entire period, with an average degree of inefficiency that is marginally higher than 45% of equipment procurement. If for model 1, the large states had a higher efficiency, within this model they seem to be only slightly more efficient than the smaller ones. After a steep drop in efficiency in the 2014-2016 period (0.200), the average efficiency increased to 0.347 in the period of 2017-2022. Compared to model 1, the EMS show increased efficiency.

Table 6 – Efficiency scores for Model 2 for Member States, period 2002 - 2022

	Country	2005-2013	2014-2016	2017-2021	2022	2005-2022
1	Austria	0.353	0.128	0.749	0	0.730
2	Belgium	0.587	0.298	0.445	0.337	0.688

	Country	2005-2013	2014-2016	2017-2021	2022	2005-2022
3	Bulgaria	0.982	0	0.386	0.809	0.975
4	Croatia	0.717	0.250	0.677	0.360	0.943
5	Czechia	0.623	0.364	0.527	0.431	0.730
6	Denmark	0.199	0.092	0.181	0.180	0.240
7	Estonia	0.259	0.090	0.239	0.228	0.326
8	Finland	0.202	0.240	0.169	0.119	0.211
9	France	1	1	1	1	1
10	Germany	0.614	0.516	0.494	0.540	0.616
11	Greece	0.126	0.080	0.226	0.114	0.207
12	Hungary	0.961	0	0.335	0.234	0.681
13	Italy	0.398	0.130	0.249	0.356	0.394
14	Latvia	0.975	0.160	0.247	0.357	0.612
15	Lithuania	0.814	0.079	0.193	0.190	0.423
16	Luxembourg	0.143	0.028	0.089	0.096	0.138
17	Netherlands	0.286	0.189	0.144	0.331	0.251
18	Poland	0.513	0.208	0.288	0.287	0.423
19	Portugal	0.476	0.132	0.481	0.595	0.697
20	Romania	0	0.153	0.334	0.593	0.740
21	Slovakia	0.663	0.145	0.231	0.344	0.516
22	Slovenia	0.840	0	0	0.479	1
23	Spain	0.460	0.277	0.430	0.555	0.543
24	Sweden	0.399	0.234	0.223	0.260	0.317
	Average	0.525	0.200	0.347	0.366	0.558

Note: Austria, Cyprus, Ireland and Malta are outliers and are excluded from the analysis.

Source: Authors' calculation.

In Table 7, similar to the first model, we estimate the waste determined by the inefficiency of public spending on equipment procurement through a DEA VRS model oriented towards inputs. Waste for each member state is estimated as follows: waste = (1-θ) x input, where input is the average annual level of equipment purchases made in the period 2005-2022. The fifth column represents the estimated waste level for each member state. As can be seen, at the EU level, the total amount of waste is quite large: 10.9 billion €. Larger states usually show larger losses than average states:

Germany (1.97), Italy (1.98), Netherlands (1.33), Poland (1.164). The description of the returns to scale is shown in the last column: with the exception of France and Slovenia, the other Member States show increased return of scale. The increase of EU involvement in equipment procurement will generate the future increase of the potential of the Member States, thus improving the EU capacity and reducing the losses generated by the purchases at the national level. It is also confirmed by the data that the increasing returns to scale can be exploited to obtain significant efficiency advantages at EU level. Each EMS would benefit from improved military capability if more attributions for procurement were allocated to the European Union.

Table 7 – The inefficiencies scores and estimated waste values for Model 2 for Member States

	Country	Efficiency score	Inefficiency	Defence equipment procurement expenditure	Estimated waste values (million €)	Type of return of scale
1	Austria	0.730	0.269	255.123	68.843	increase return of scale
2	Belgium	0.688	0.311	350.623	109.121	increase return of scale
3	Bulgaria	0.975	0.024	160.573	3.884	increase return of scale
4	Croatia	0.943	0.056	96.316	5.489	increase return of scale
5	Czechia	0.730	0.269	311.821	83.936	increase return of scale
6	Denmark	0.240	0.759	510.097	387.487	increase return of scale
7	Estonia	0.326	0.673	88.403	59.541	increase return of scale
8	Finland	0.211	0.788	739.714	583.085	increase return of scale
9	France	1	0	6867.970	0	constant return of scale
10	Germany	0.616	0.383	5155.018	1976.959	increase return of scale
11	Greece	0.207	0.792	1139.109	902.918	increase return of scale
12	Hungary	0.681	0.318	315.043	100.375	increase return of scale
13	Italy	0.394	0.605	3274.008	1982.235	increase return of scale
14	Latvia	0.612	0.387	72.019	27.935	increase return of scale

	Country	Efficiency score	Inefficiency	Defence equipment procurement expenditure	Estimated waste values (million €)	Type of return of scale
15	Lithuania	0.423	0.576	153.387	88.497	increase return of scale
16	Luxembourg	0.138	0.861	86.780	74.770	increase return of scale
17	Netherlands	0.251	0.748	1778.553	1331.332	increase return of scale
18	Poland	0.423	0.576	2020.464	1164.225	increase return of scale
19	Portugal	0.697	0.302	324.874	98.389	increase return of scale
20	Romania	0.740	0.259	586.545	152.398	increase return of scale
21	Slovakia	0.516	0.483	227.545	110.037	increase return of scale
22	Slovenia	1	0	44.672	0	constant return of scale
23	Spain	0.543	0.456	1943.525	886.805	increase return of scale
24	Sweden	0.317	0.682	1146.293	781.945	increase return of scale
	Average	0.558	0.441	Total EU24	10980.217	

Note: Austria, Cyprus, Ireland and Malta are outliers and are excluded from the analysis.

Source: Authors' calculation.

Robustness check for model 2

Model 4

Input Equipment procurement expenditure

Output Employment in the defence industry and turnover in the defence industry

Similar to the model 1, for model 2 weperform a robustness check by taking into account other output variables. Our analysis involves changing the R&D expenditure output variable with two other variables: employment in the defence industry and turnover for firms in the defence industry. Due to the availability of data, this analysis is performed only for the data regarding the year 2022. The results obtained are presented in Table 8, for all member states and then with the elimination of the 3 outlier states. The choice of variables for robustness was done accordingly, the estimates being similar to model 2. The average for the efficiency scores is 0.553, similar to the previous one of 0.589. The countries that are considered efficient are France and Slovenia, also efficient for model 2, along with Bulgaria and Portugal.

Table 8 – Efficiency scores for Model 4 for MS (robustness for model 2) (EU27 and EU24)*

	Country (EU27)	Efficiency score		Country (EU24)	Efficiency score
1	Austria	0.323	1	Austria	0.999
2	Belgium	0.278	2	Belgium	0.278
3	Bulgaria	1	3	Bulgaria	1
4	Croatia	0.485	4	Croatia	0.630
5	Cyprus	0.149			
6	Czechia	0.409	5	Czechia	0.409
7	Denmark	0.089	6	Denmark	0.155
8	Estonia	0.215	7	Estonia	0.729
9	Finland	0.245	8	Finland	0.245
10	France	1	9	France	1
11	Germany	0.807	10	Germany	0.807
12	Greece	0.045	11	Greece	0.065
13	Hungary	0.165	12	Hungary	0.187
14	Ireland	0			
15	Italy	0.468	13	Italy	0.468
16	Latvia	0.248	14	Latvia	0.829
17	Lithuania	0.060	15	Lithuania	0.285
18	Luxembourg	0.123	16	Luxembourg	0.650
19	Malta	0			
20	Netherlands	0.542	17	Netherlands	0.500
21	Poland	0.014	18	Poland	0.037
22	Portugal	1	19	Portugal	1
23	Romania	0.104	20	Romania	0.174
24	Slovakia	0.153	21	Slovakia	0.322
25	Slovenia	0.999	22	Slovenia	1
26	Spain	0.893	23	Spain	0.893
27	Sweden	0.566	24	Sweden	0.566
	Average	0.384		Average	0.553

* EU27 means that the analysis was carried out with outliers, EU24 means that the analysis was carried out without outliers.

Source: Authors' calculation.

Up to this moment, the empirical analysis through the two models, 1 and 2, has shown that the Member States provide services in an at least inefficient way (almost 50%), with a significant amount of waste. Under these conditions, there may be potential benefits of a more comprehensive European policy in the military field.

Model 5

Input	Equipment procurement expenditure (average for 2005-2022)
Ouptut	Type of armament (stock of weaponry: land, air and naval in 2022)

We complete the robustness check for the second model by considering, as output, the stock of each type of military equipment (land, air and naval). For the accuracy of the results, all variables have been standardized by the min-max method. For model 5a, we use as input variable defence procurement expenditure, and as output the number of military equipment specific to land defence equipment (tanks, ATV, IFV, artillery). For model 5b, the specific output variable is given by the number of military equipment in the field of air defence equipment (fighter aircraft, transport, training, helicopters). For model 5c, the specific output variable is given by the naval military equipment which can be: aircraft carriers, submarines, frigates, corvettes.

Table 9 presents the results obtained from the analysis. First, as can be seen, the average efficiency score for the land weaponry is significantly higher than that determined for the general function generated by model 2. The Data Envelopment Analysis (DEA) results for the efficiency of investments in ground forces' capabilities across EU countries reveal a diverse range of efficiency scores. The analysis highlights several countries achieving maximum efficiency while others exhibit varying degrees of inefficiency. Here's a detailed discussion of these results. For example, if for the general model the average efficiency was 0.558, in this case the average is significantly increased at 0.642. One explanation could also be that most European countries have a strong industrial base producing military equipment of this type. However, it should be noted that there is a cumulative inefficiency of 0.358 across the EU states, which can be significantly reduced. Countries with maximum efficiency (Efficiency Score = 1) are Bulgaria, France, Greece, Italy, Portugal, Romania, Slovenia. The motives for obtaining this results could be: effective resource allocation (indicating highly effective resource allocation and procurement processes); strategic focus (have a strategic focus on ground forces, ensuring that investments are well-targeted and result in maximum operational capabilities); operational practices (have efficient operational practices and streamlined procurement procedures contribute to their high efficiency scores); contextual factors (geopolitical context and specific defence needs may drive these countries to prioritize and optimize their ground forces, resulting in higher efficiency). Countries with high efficiency scores (0.7 < Efficiency Score < 1) are represented by Germany (0.807), Latvia (0.829), Spain (0.931), Estonia (0.729). The motives for obtaining this results could be: resource allocation; strategic balance across multiple domains (land, air, naval), slightly impacting their ground forces' efficiency but still maintaining high overall effectiveness. Countries with moderate efficiency scores (0.3 < Efficiency Score < 0.7) are represented by Croatia (0.648), Czechia (0.409), Austria (0.475), Lithuania (0.294), Luxembourg (0.650), Netherlands (0.542), Poland (0.335), Slovakia (0.328), Sweden (0.566). The reasons behind their results could be: procurement efficiency; optimization of resource allocation; operational practices; strategic diversification (these nations might be investing in a diversified defence strategy, potentially impacting the specific efficiency of their ground forces). Countries with Low Efficiency Scores (Efficiency Score < 0.3) are represented by Belgium (0.278), Denmark (0.155), Finland (0.245), Hungary (0.187). The reasons behind their results could be: bureaucratic inefficiencies, higher procurement costs, strategic priorities that do not heavily focus on ground

forces, or logistical constraints could be contributing to these lower scores; lack of reforms in their defence procurement processes.

Second, the efficiency scores are similar to those for the general function, in line with what was obtained in Model 2. If previously an average of 0.558 was obtained, 0.590 is realized for the air defence weaponry. The explanation lies in the fact that many of the EU states do not benefit from and have not developed a defence industry in this military domain. The champion states are the big ones France and Germany, which have strong companies in this field. Most European states have low efficiencies of less than 0.5. The cumulative inefficiency in this sub-function implies 0.41. Countries with maximum efficiency (Efficiency Score = 1) are represented by Bulgaria, France, Germany, Italy, Portugal. The possible reasons behind these results could be: best practices implemented (these countries should continue their current practices while seeking incremental improvements and sharing best practices with less efficient countries); sustainability (ensuring sustainability of these practices and adapting to evolving defence needs will be important to maintaining their high efficiency). Countries with high efficiency scores (0.7 < Efficiency Score < 1) are Estonia (0.729), Greece (0.949), Latvia (0.829), Spain (0.958), Sweden (0.867). The motives for their results could be: optimization of weaponry (focusing on fine-tuning procurement processes and addressing minor inefficiencies) and balanced investment strategy while optimizing air capabilities. Countries with moderate efficiency scores (0.3 < Efficiency Score < 0.7) are represented by: Belgium (0.541), Croatia (0.690), Czechia (0.409), Finland (0.416), Austria (0.554), Lithuania (0.453), Netherlands (0.566), Romania (0.312), Slovakia (0.324). The possible reasons for their efficiency could be strategic focus (reallocation of resources for another defence capabilities) and process deficiences (streamlining procurement processes and bureaucratic hurdles can significantly improve efficiency scores).

Third, for the model for the naval defence weaponry, they are significantly lower than those for the overall model. The waste rates, which are 67% for the third model are highly significant and the highest among the three models. The explanation shows that, with the notable exception of France, the rest of the European countries do not have an adequate shipbuilding industry. Country with maximum efficiency (efficiency score = 1) is only one, France, and a possible explanation could be its naval tradition (France's long-standing naval tradition and substantial maritime interests necessitate a strong and efficient naval force). Four other European countries (Germany, Netherlands, Sweden and Spain) have high efficiencies above 0.5; but the rest of the European countries have extremely low efficiencies, some of them even being inefficient (Bulgaria, Croatia, Estonia, Latvia, Lithuania, Estonia). It should be noted that these countries are also small countries that cannot allocate sufficient resources to this area.

Table 9 – Efficiency scores for Model 5 (land, air and naval weaponry) for Member States (robustness for model 2)

	Country	Land weaponry	Aircraft weaponry	Naval weaponry
1	Austria	0.475	0.554	
2	Belgium	0.278	0.541	0.317
3	Bulgaria	1	1	0
4	Croatia	0.648	0.690	0
5	Czechia	0.409	0.409	

	Country	Land weaponry	Aircraft weaponry	Naval weaponry
6	Denmark	0.155	0.192	0.178
7	Estonia	0.729	0.729	0
8	Finland	0.245	0.416	0.399
9	France	1	1	1
10	Germany	0.807	1	0.807
11	Greece	1	0.949	0.187
12	Hungary	0.187	0.187	
13	Italy	1	1	0.476
14	Latvia	0.829	0.829	0
15	Lithuania	0.294	0.453	0
16	Luxembourg	0.650	0.110	
17	Netherlands	0.542	0.566	0.574
18	Poland	0.335	0.085	0.247
19	Portugal	1	1	0
20	Romania	1	0.312	0.235
21	Slovakia	0.328	0.324	
22	Slovenia	1	0	
23	Spain	0.931	0.958	0.908
24	Sweden	0.566	0.867	0.594
	Average	0.642	0.590	0.329

Note: For land and aircraft weaponry models, Cyprus, Ireland and Malta are outliers and are excluded from the analysis. Additionally, Austria, Czechia, Hungary, Luxembourg, Slovakia and Slovenia are outliers for the naval weaponry model.

Source: Authors' calculation.

4.3. Defence spending efficiency analysis for EU vs. USA and UK

For our approach, it is useful to compare our results with those of other states that have encountered similar problems. And the country that best fits the European construction, both politically and economically, is the US. In our field of analysis, the defence, exclusive competence rests with the Department of Defence, which is solely responsible for managing the defence budget, including defence and security purchases. Traditionally, the Department of Defence is the ministry with the largest budget in the US, this amounting to $10918.9 billion in the analyzed period, and for military

acquisitions to $2720.3 billion. Compared to the EU27, the budget allocated to defence in the US is 5 times higher, and the one for acquisitions is 6 times higher.

The US defence supplier market is an extremely competitive one; the first 12 companies in the world by turnover are American. These large companies concentrate more than 80% of the defence procurement and R&D budget (Heuninckx, 2017), which allows for significant economies of scale. With a significant amount of resources, the Department of Defence funds and oversees all defence research and development expenditures, which are the largest in the world. This ministry finances a wide range of initiatives related to infrastructure, materials and technological and military innovations, each project having to demonstrate how to develop national security and ultimately the general well-being of the population. Multidisciplinary projects that involve the transformation of scientific discoveries into practical products have a greater importance in the vision of the ministry (Briani, 2013). However, where there are fundamental differences compared to the EU27, it is on the budget side, and especially its destinations. The US defence budget is allocated for equipment purchases (23%) and R&D (14%), while in the EU purchases receive 20% and R&D only 4%.

In order to be able to make a comparison between the results, we develop a DEA model in which, in addition to the EU member countries, we also introduce the US. Because of Brexit, in our main analysis (models 1 and 2) we did not introduce the UK, but since this analysis assumes an international comparability, we introduce it as a reference point and make estimates for the UK as well. Table 10 shows the results obtained by estimating the previous models used in the analysis.

As can be seen in column 2, the US is the only country that is efficient within the deployed troops model. The MS, including the big ones, and the UK show a lower degree of efficiency compared to the US. The results are not surprising considering that the US deploys the largest number of troops (over 330 000), the MS being at considerable distances from these values (the most important state, France has 12 000, and many of the member states having under 1 000). For model 2, related to equipment procurement, by introducing the two states, US and UK, the situation changes significantly compared to previous estimates. In this case, there are only two countries with a maximum efficiency of 1, US and France. UK also gets a good score of 0.669. Large and medium-sized MS obtain efficiency scores below 0.4 (Finland, Germany, Spain, Sweden), but most states (17 states) obtain scores of 0, showing their extreme inefficiency. The result is not surprising considering that all these states, besides the fact that they allocate small amounts for military procurement and even smaller in the case of funds for R&D.

Table 10 – Efficiency scores for Model 1 (deployed troops) and 2 (defence procurement) for Member States vs USA and UK

	Model 1			Model 2	
	Country	Efficiency score		Country	Efficiency score
1	Austria	0.376	1	Austria	0
2	Belgium	0.293	2	Belgium	0
3	Bulgaria	0	3	Bulgaria	0
4	Croatia	0	4	Croatia	0
5	Cyprus	0.265	5	Cyprus	0

	Model 1			Model 2	
	Country	Efficiency score		Country	Efficiency score
6	Czechia	0.549	6	Czechia	0
7	Denmark	0.167	7	Denmark	0
8	Estonia	0.362	8	Estonia	0
9	Finland	0.192	9	Finland	0.100
10	France	0.317	10	France	1
11	Germany	0.299	11	Germany	0.396
12	Greece	0.243	12	Greece	0.024
13	Hungary	0	13	Hungary	0
14	Ireland	0.538	14	Ireland	0
15	Italy	0.422	15	Italy	0.063
16	Latvia	0	16	Latvia	0
17	Lithuania	0	17	Lithuania	0
18	Luxembourg	0.257	18	Luxembourg	0
19	Malta	0	19	Malta	0
20	Netherlands	0.225	20	Netherlands	0.097
21	Poland	0.592	21	Poland	0.101
22	Portugal	0.429	22	Portugal	0
23	Romania	0	23	Romania	0.054
24	Slovakia	0	24	Slovakia	0
25	Slovenia	0.462	25	Slovenia	0
26	Spain	0.524	26	Spain	0.135
27	Sweden	0.225	27	Sweden	0.201
28	UK	0.219	28	UK	0.669
29	USA	1	29	USA	1
	EU Average	0.250		EU Average	0.080

Source: Authors' calculation.

After the separate identification of the efficiency of the European states compared to the US and the UK, our approach continues with a new working hypothesis: making comparisons considering the 27 Member States as a whole, and not as separate entities. The results are presented in Table 11,

separated for the two models. Regarding model 1 (deployed troops), two results of maximum efficiency 1 are obtained, for the EU27 and the US, a score of less than 0.5 being obtained by the UK. And by removing the UK from the analysis, the results are validated again: EU27 and the US would have the same efficiency of 1. Regarding model 2, the results are maintained: the EU27 and the US have the maximum efficiency, and the UK of 0.5. The obtained results have important practical implications.

In the case of introducing the US for comparability in separate models with each MS, it had the highest efficiency in both cases, as was natural considering the budget allocations for defence, R&D and deployed troops. In these cases, there are 27 armies and distinct organizational systems in the EU, major decisions in the field of defence being taken by each state separately. At the EU level, there is a direct control over some limited activities in the military field (EUFOR, Eurocorps and EU battlegropus).

Table 11 – Efficiency scores for Model 1 and 2 for EU27 vs USA and UK

Model 1					Model 2			
	Country	Efficiency score	Country	Efficiency score	Country	Efficiency score	Country	Efficiency score
1	EU27	1	EU27	1	EU27	1	EU27	1
2	USA	1	USA	1	USA	1	USA	1
3	UK	0.406			UK	0.548		

Source: Authors' calculation.

Compared to every MS, the American system is completely different in terms of public spending and military power (Hartley, 2023). Starting from the data record, it is possible to promote increased collaboration between Member States, more centralized common purchases and shared R&D. The efficiency of the defence system could be positively impacted by these joint approach initiatives, leading to considerable cost savings. Starting from the positive example of the US, the centralization of public procurement and R&D in the field of defence would generate significant economies of scale and through the practical applicability of R&D to potential significant technological advances for civil applications (Ostanina & Tardy, 2024). A centralized defence system in these two areas could eliminate the redundancy, duplication and inefficiency manifested at the level of the Member States, which could ultimately generate more cohesive and interoperable military capabilities.

5. Building scenarios on defence outcomes

This section explores policy scenario aimed at enhancing the defence outcomes of Member States through improved military operational capability and collaborative procurement strategies. By building scenarios around waste reduction and collaborative procurement, we analyse how different policy interventions could impact the future defence posture of the EU and provide projections and insights that help understand the implications of different policy choices on deployed troops and collaborative defence spending. The findings are intended to guide decision-makers in optimising defence expenditure, increasing military readiness, and fostering greater cooperation among Member States.

5.1. Enhance military operational capability

Enhancing military operational capability is essential for the European Union (EU) as it seeks to address evolving security challenges and maintain a robust defence posture. This is particularly relevant given the increasingly complex global security environment, marked by emerging threats, geopolitical tensions, and the need for rapid response capabilities. Strengthening military operational capability ensures that Member States are well-prepared to protect their territories, respond effectively to crises, and contribute to international peace and stability (Lucarelli et al. 2012). This section focuses on optimising defence expenditure, particularly through reducing waste and improving efficiency in resource allocation. By minimising waste in defence budgets, Member States can reallocate savings towards enhancing their military readiness, increasing the percentage of deployed troops, and ensuring that their armed forces are adequately equipped to meet contemporary security demands. Efficient defence spending is not only a matter of fiscal responsibility but also a strategic imperative that enhances the EU's overall defence capacity and resilience (Dorn et al., 2024). The relevance of enhancing military operational capability is further underscored by the need for greater interoperability and cohesion among Member States. A more capable and coordinated military force enhances the EU's ability to act as a unified entity in response to threats, whether they are conventional, asymmetric, or hybrid in nature (Baciu & Doyle, 2019). Additionally, improving operational capabilities aligns with the EU's broader strategic objectives of achieving greater strategic autonomy and reducing reliance on external powers for security (Bassot, 2020).

These scenarios were designed to evaluate how different levels of troop deployment, as a key operational efficiency factor, could influence the optimisation of defence spending. Specifically, we modeled waste reduction outcomes under different percentage increases in troop deployment for the EU27 and individual Member States. The scenarios modeled a range of percentage increases in the proportion of deployed troops relative to total military personnel to assess their impact on the reduction of defence-related waste for Member States.

The key features of the scenarios are:

1. Baseline scenario (0 % Increase): This scenario served as the control, with no increase in troop deployment. It provides a comparison with the other scenarios. With few exceptions, the baseline values are the value from 2022, the last observed year. Exceptions are made for the cases where the 2022 value varies substantially from the values registered from other years, in these few cases the option being the use of the average value for 2005-2022.

2. Incremental increases: Each subsequent scenario introduced incremental increases in troop deployment, ranging from 5 % to 30 %, to understand the gradual effects on waste reduction.
3. Country-specific and EU27 analysis: The scenarios were applied both at the level of individual countries (Germany, Italy, Spain, Portugal, and Sweden) and at the EU27 level, providing a broader perspective on how these changes could affect overall EU defence spending.
4. Measurement of waste reduction: For each scenario, the change in defence-related waste was calculated in monetary terms (euro/capita), allowing for a clear assessment of how increases in troop deployment correlate with reductions in inefficiency and waste.

The results obtained for the scenarios involve analysing the relationship between an increase in the percentage of deployed troops and the predicted waste reduction across several Member States.

To estimate this relationship between changes in waste when changing the percentage of deployed troops, a time series regression model with differenced values was estimated, with the waste as dependent variable, and as independent variable the deployed troops as percentage of total armed forces.

Table 12 shows the results for the six scenarios for deployed troops considering waste reduction in defence expenditure per capita. This relationship is negative for all scenarios: increasing deployment will lead to decreasing waste. In the case of a 5 % increase, deployment reaches 2.7 %. In the case of a 10 % increase, the increase will surpass 2.9 %. For the scenarios with high values, 15-30 %, the increase in troop deployment will be even more consistent, with values between 3.05 % and 3.447 %, showing a consistent improvement from the baseline scenarios.

Table 12 – Predicted values of percentage of deployed troops (in armed forces) and waste reduction for scenarios 5-30 %

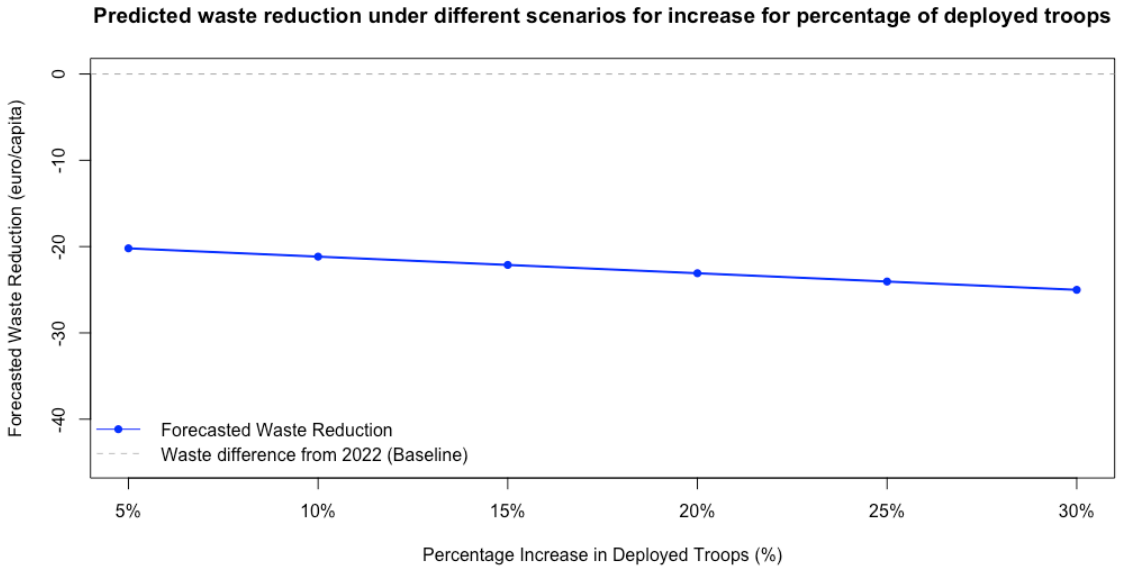
Increases in percentage of deployed troops		Predicted waste reduction (€/capita)
Percentage		
5 %	2.785	-20.201
10 %	2.917	-21.163
15 %	3.050	-22.125
20 %	3.182	-23.087
25 %	3.315	-24.049
30 %	3.447	-25.011
Estimated coefficient	$\beta = -7.255$	

* The baseline value is the average percentage value of deployed troops in total armed forces from 2022, of 2.65 %.

Source: Authors' estimations.

With a 5 % increase in deployed troops, the predicted waste reduction is -€20.2 per capita. As the percentage of deployed troops increases, the waste reduction deepens, reaching -€25.01 per capita with a 30 % increase in deployed troops. In nominal value, considering that the EU population is approximately 450 million, the waste reduction at 30 % increase in deployment is estimated at €11.2 billion.

Figure 2 – Predicted waste reduction under different scenarios for increase for percentage of deployed troops



Source: Authors' representation.

Figure 2 shows the dynamics of the six scenarios regarding the increase in deployed troops and their positive impact on waste reduction. For all increase scenarios, the average reduction in waste ranges between above €20-€25 per capita. The aggregated analysis for the EU27 reveals a negative relationship between the percentage of deployed troops and waste. This means that as the percentage of deployed troops increases, waste decreases. This result suggests that improving proportion of military personnel being deployed leads to a greater efficiency in defence spending regarding deployment troops (waste reduction).

Within the EU, the 27 MS show a large heterogeneity in the deployment of troops. Under these conditions, for a better representation of the possible relationships, we analyse a number of MS to observe the effect of the reduction of waste on the deployment of troops at the national level. The countries analysed are three large countries, Germany, Italy and Spain, and two medium-sized countries, Portugal and Sweden. Figure 3 shows the visual representation of dynamics of the predicted waste reduction under different scenarios for increasing the percentage of deployed troops for these five MS.

Table 13 – Predicted waste under different scenarios for increasing the percentage of deployed troops for Germany, Italy, Portugal, Spain and Sweden

	Germany*		Italy*		Portugal*		Spain*		Sweden**	
Increases in percentage of deployed troops (%)	Depl. troops (%)	Pred. waste red.	Depl. troops (%)	Pred. waste red.	Depl. troops (%)	Pred. waste red.	Depl. troops (%)	Pred. waste red.	Depl. troops (%)	Pred. waste red.
5 %	1.965	-167,15	2.762	-181.51	2.312	-13.63	2.053	-106.73	2.804	-35.539
10 %	2.059	-175,11	2.893	-190.06	2.422	-14.28	2.151	-111.7	2.937	-36.665
15 %	2.153	-183,07	3.025	-198.61	2.533	-14.93	2.249	-116.66	3.071	-38.417
20 %	2.246	-191,03	3.156	-207.82	2.643	-15.58	2.347	-121.13	3.204	-40.044
25 %	2.340	-198,99	3.288	-216.36	2.753	-16.23	2.444	-126.09	3.338	-41.796
30 %	2.433	-206,95	3.419	-224.91	2.863	-16.88	2.542	-141.98	3.471	-43.422
Estimated coefficient	$\beta = -86.05$		$\beta = -65.76$		$\beta = -5.9$		$\beta = -49.64$		$\beta = -12.51$	

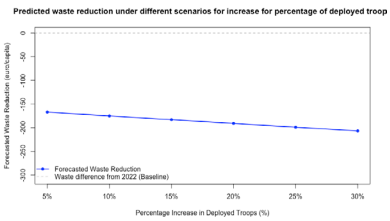
*the baseline value is the percentage of deployed troops in 2022: 1.87 % for Germany, 2.63 % for Italy, 2.2 % for Portugal, 1.95 % for Spain.

** for Sweden, the baseline value is the average percentage of deployed troops for 2005-2022, of 2.67 %.

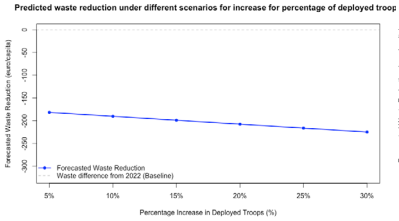
Source: Authors' estimation.

Figure 3 – Predicted percentage of deployed troops under different scenarios for Germany, Italy, Portugal, Spain and Sweden

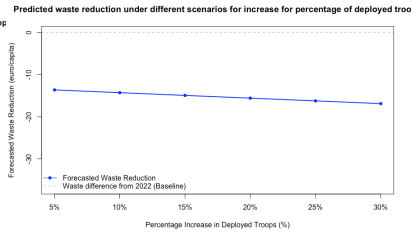
Germany



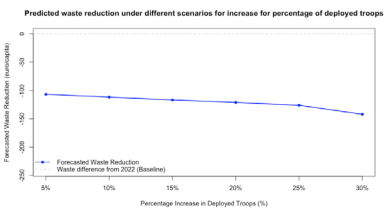
Italy



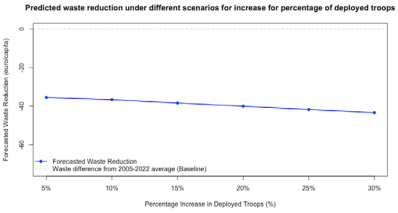
Portugal



Spain



Sweden



Source: Authors' representation.

The scenarios revealed that increasing the percentage of deployed troops leads to progressively larger reductions in waste across the EU27 and specific Member States. However, the magnitude of these reductions varies significantly between countries. Countries like Germany, Italy and Spain exhibited the greatest potential for waste reduction as troop deployment increased, while countries like Sweden and Portugal showed more limited reductions, indicating potentially higher initial efficiency or the presence of other factors affecting waste.

The EU27 as a whole demonstrated that increasing troop deployment by up to 30 % could result in substantial waste reductions, suggesting that collaborative efforts across Member States could optimise defence spending at a regional level.

Increasing the number of deployed troops offers several strategic, operational, and political advantages and benefits, both for individual Member States and for the European Union as a whole. These benefits span across various dimensions, including enhancing military readiness, fostering international cooperation, demonstrating political commitment, and improving crisis response capabilities (Baciu & Doyle, 2019). It may enhance a Member State's ability to respond quickly and effectively to military threats, natural disasters, or other emergencies and leads to increased flexibility in strategic and tactical operations (Morillas, 2020). Troop deployment can also increase operational experience and expertise as soldiers gain practical experience in real-world operations. Deployment of troops in multinational exercises enhances the ability of Member States to operate effectively in joint operations, working alongside other countries and adapting to diverse operational environments. Contributing to international missions can further be a tangible demonstration of a Member State's commitment to its allies and international partnerships, such as NATO or the EU (Kirchner & Sperling, 2018). Further, a larger and more visible military presence can serve as a deterrent to potential aggressors (Violakis, 2018).

For the EU27, increasing the number of deployed troops across the EU enhances the collective defence posture of the Union, serving as a stronger deterrent against potential adversaries. A higher number of deployed troops contributes to the integration of defence capabilities across Member States, promoting interoperability and standardisation of military forces (Smith et al., 2015). This integration enhances the EU's ability to act as a unified force in response to external threats. More troops available for deployment improves the EU's capacity to manage conflicts, provide humanitarian assistance, and stabilise regions in turmoil. A more robust deployment capability enhances the EU's role as a global security provider (Karampekios et al., 2017). By demonstrating a commitment to maintaining and deploying military forces, the EU can strengthen its diplomatic leverage in international negotiations, particularly in security and defence matters. Increasing the number of deployed troops supports the EU's long-term goal of achieving strategic autonomy, having the capability to act independently and effectively in its defence without reliance on external powers (Zandee, 2022). Increasing deployed troops reinforces the principle of collective action and shared responsibility among Member States, strengthening the EU's internal cohesion.

5.2. Enhance defence sector collaborative procurement

In March 2024, the European defence industrial strategy (EDIS) was launched. The aim of the policy is to address vulnerabilities in the EU's defence preparedness that have been exposed by the conflict between Russia and Ukraine (Tyushka & Schumacher, 2021). Entitled 'A New European Defence Industrial Strategy: Achieving EU Readiness through a Responsive and Resilient European Defence Industry', the strategic document aims to support and enhance Member States' efforts to coordinate their actions and to increase investments in security and defence (Ewers-Peters, 2021). To complete

the EDIS, the European Commission presented a proposal for a regulation that would create a 'European defence industrial programme' (EDIP), which would allow the execution of the measures presented in the EDIS and which represents the financial component of the European plan. If funded through this EDIP, EDIS will become an action plan under the current EU budget, the 2021-2027 multiannual financial framework (MFF) (Besch, 2023). The European Commission considers the strategy to be 'the structural preparation of the EU's defence' and the intention is to gradually replace the emergency measures implemented starting from 2022. To motivate the Member States to invest more, better, collectively and European, these proposed policies present an ambitious agenda with incentives that are tailored specifically to each state (Strandquist, 2021). The success of the plan will depend, however, on how willing Member States and their individual defence industrial sectors are to step up and take greater responsibility for defence, provided the EU does not adopt a more extensive defence mandate through treaty reform (Ostanina & Tardy, 2024).

The target of the new EU plans is to solve a European structural problem, namely, the fragmentation of European defence (Bakardjieva Engelbrekt et al., 2024). Member States generally consider cooperation only when it coincides with national plans, benefits national industry or strengthens a strategic partnership (European Defence Agency, 2022), but in most cases opportunities for cooperation are often lost (Zandee, 2022). By using this strategy, the EU promotes increased European defence cooperation through two distinct channels: between Member States by encouraging cooperative financing and procurement of weapons and equipment, and between defence companies by providing incentives for the joint development of new capabilities and a increased resistance to crisis (Ostanina & Tardy, 2024). If EDIS is successful, it will help lead to the European defence industrial and technological base (EDTIB), which will support the Union's efforts to be defence-ready. Therefore, by 2030, the Commission wants Member States to spend half of their procurement budgets on EU equipment; by 2035, this percentage would increase to 60 %. The promotion of such targets represents a high goal that requires a strong coordination at the level of the EU and the Member States (Conde et al., 2024).

Second, the aim of the joint development of the EU's defence capabilities is to achieve economies of scale (Ostanina & Tardy, 2024). The continued dependence of Member States on their own defence industries has led to the duplication of weapons systems (Table 14). By 2017, there was a 6:1 difference between the types of weapon systems being used by the US and Europe. The aerospace sector has an average production duplication ratio of 1.8:1 between US and European production lines, while the marine sector has the highest average production duplication ratio of 5:1. The field segment contains 17 and 2 production lines respectively. Not only does defence spending fall, but this doubling also lowers the effectiveness of defence spending.

Table 14 – Platforms and systems in use/in production for Member States vs USA

		In use		In production	
	Platforms and systems	Europe	USA	Europe	USA
Land	Tanks	17	1	2	1
	AIFV/APC	21	2	11	1+MRAPs*
	155mm sp howitzer	17	2	4	0
Air	Fighter/ground attack	20	6	3	3

		In use		In production	
	Attack helicopters	6	1	2	1
	Anti-ship missiles	8	1	7	1
	Air-to-air missiles	5	3	2	3
Sea	Frigates	29	4	2	0
	Diesel submarines	6	1	2	0
	Nuclear submarines	2	1	1	1
	Total	131	22	36	10

Source: SIPRI and NATO databases.

According to the 2020 CONE Report, each major US initiative generates three projects, on average, from EU countries, with each programme getting a third of the money the other could have obtained through continental cooperative development. It is extremely difficult to determine the true costs of duplication, given the lack of transparent data on most defence programmes. Furthermore, as defence spending has shrunk, many weapon systems have been used well beyond their intended lifetimes. These expansions undermined efforts by European nations to develop cooperative defence capabilities that could have resulted in at least partial standardisation of military equipment, discouraging Member States from upgrading their defence stocks (Briani, 2013).

Third, the objective of EDIS is to improve the European Union's 'strategic autonomy', or its ability to take independent action in the event of a security crisis (Béraud-Sudreau & Pannier, 2021). The extent to which the EU depends on the US for defence was highlighted by Russia's large-scale invasion of Ukraine. Supply is one of them. Of the arms purchased by EU countries between February 2022 and June 2023, 78 % went to manufacturers outside the EU, with 63 % destined for the US alone. During this peak arms-procurement period, Member States actually spent only €21 billion out of a total of over €100 billion on purchasing weapons from European manufacturers. However, the propensity of Member States to buy 'mainly themselves and from abroad' is not exclusive to emergency situations (Draghi Report, 2024). The amount of weaponry that European nations bought from the US increased from 35 % in 2014-2018 to about 55 % in 2019-2023, according to the Stockholm International Peace Research Institute (SIPRI; Struk et al., 2024).

One of the Commission's goals is to procure at least 40 % of defence equipment collaboratively by 2030, ensure that by the same deadline, the value of intra-EU defence trade represents at least 35 % of the value of the Union's defence market', and that at least 50 % of Member States' equipment budgets are dedicated to European acquisitions (60 % by 2035) (Letta, 2024).

The situation of the European collaborative/defence procurement ratio separately for the 27 MS is presented in Table 15. The estimates made as a result of the analysis identify major differences between the EU states. Thus, the champion of the application of the collaborative procurement mechanism is Spain with over 45 %, followed by Germany and Italy with over 39 %. Belgium and Luxembourg also show high values of over 35 % of the indicator, and France and Poland over 25 %. A number of other states present values between 1.3-13 % (7 states). Thirteen MS do not use this European public procurement mechanism at all, having zero or close to zero collaborative defence procurement expenditure ratio.

However, defence procurement remains highly segmented within the EU – far more so than any other area of European procurement, and as such is economically inefficient. According to studies (Heuninckx, 2017), reducing market fragmentation, harmonising requirements in terms of time and scope and, most importantly, improving the efficiency of large procurement programmes could save 10-30 % of European defence procurement costs.

Member States occasionally turn to collaborative procurement, whereby they agree to jointly purchase and/or maintain certain expensive defence equipment, in an effort to enhance such efficiency (Heuninckx, 2017). As a result of equipment standardisation and interoperability among participating states, collaborative procurement is anticipated to bring operational and industrial benefits as well as political advantages by promoting mutual understanding among participating states (Briani, 2013). In addition, collaborative procurement is anticipated to bring cost benefits during the development and production phase of the system, such as sharing R&D costs and generating economies of scale during production. Furthermore, states may acquire military equipment through joint procurement that would be beyond their means due to budgetary constraints, inadequate industrial capacity, or other factors (Karampekios et al., 2017). For smaller governments, it is therefore the only option for purchasing weapons that gives them the ability to control the operational and technical parameters of the systems while being affordable.

States occasionally resort to collaborative procurement when they agree to purchase expensive defence equipment and jointly fund development costs, in an effort to achieve economies of scale and share the costs of developing such equipment (Heuninckx, 2017).

Table 15 – Ratio of European collaborative defence procurement for Member States in 2005-2022 (average)

Country	Collaborative defence procurement expenditure (€ million)	European collaborative defence procurement (€ million)	Ratio European collaborative defence procurement
Austria	0	0	0
Belgium	205.068	106.570	35.765
Bulgaria	0	0	0
Croatia	0	0	0
Cyprus	0.011	0.011	0.012
Czechia	0	0	0
Denmark	0	0	0
Estonia	3.817	3,.817	3.572
Finland	9.533	9.533	1.386
France	1689.333	1689.055	25.103
Germany	2018.585	1987.569	39.703
Greece	0.263	0	0
Hungary	3.562	2.483	2.353
Ireland	0	0	0

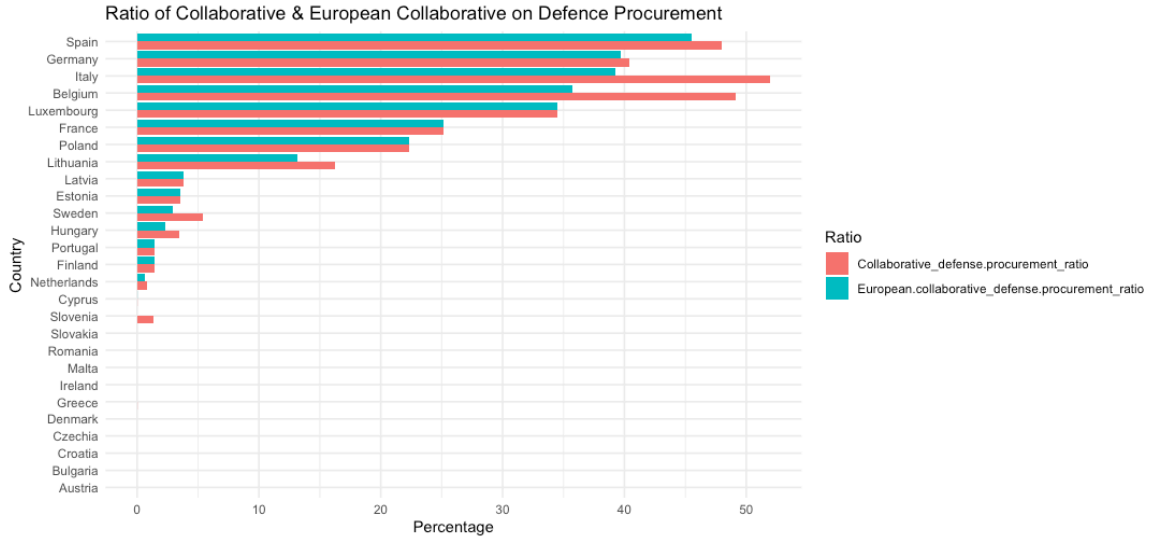
Country	Collaborative defence procurement expenditure (€ million)	European collaborative defence procurement (€ million)	Ratio European collaborative defence procurement
Italy	1655.205	1202.720	39.278
Latvia	6.804	6.804	3.787
Lithuania	49.497	38.885	13.171
Luxembourg	40.396	40.396	34.456
Malta	0	0	0
Netherlands	11.4	9.383	0.647
Poland	595.606	595.606	22.339
Portugal	3.610	3.563	1.444
Romania	0	0	0
Slovakia	0	0	0
Slovenia	0.286	0	0
Spain	933.160	869.549	45.489
Sweden	57.775	31.300	2.923
Average	269.77	244.342	10.053

Source: Own elaboration based on EDA, NATO and SIPRI data.

The analysis of the distribution of European collaborative procurement (Figure 4) indicates large variations across countries, as presented in the figure below, with a number of countries having null values. Hence, we focused on a subset of 14 Member States (Belgium, Estonia, Finland, France, Germany, Italy, Latvia, Lithuania, Luxembourg, Poland, Portugal, Slovenia, Spain, and Sweden) that have non null values for the European collaborative procurement ratio, and then further narrowed the focus to specific countries like Germany, Italy, Spain, Belgium, Portugal, and Sweden. The rationale for selecting these countries and groups is based on their collaborative procurement expenditure relative to defence procurement expenditure and their significance in EU defence dynamics.

The 14 MS with a non-null ratio of collaborative procurement expenditure have engaged in some form of collaborative procurement, making them relevant to analyse in the context of potential savings and efficiency gains. Focusing on countries with active collaborative procurement allows for a more accurate and relevant analysis, as these countries are already participating in joint efforts that could benefit from further optimisation through waste reduction. The analysis presents, for the 14 MS, the predicted variation in waste, based on different increase scenarios of EU equipment expenditure ratio, ranging from 5 % to 30 %.

Figure 4 – Ratio of collaborative & EU procurement under different waste reduction scenarios (2005-2022 average)



Source: Authors' representation.

The objective of these scenarios was to evaluate the potential waste reduction that could be achieved by increasing the European collaborative procurement ratio in the defence sector across several Member States. The analysis focused on three main parts:

1. EU14 analysis: this group includes Member States with non-zero collaborative procurement ratios. The main goal was to understand how increases in European collaborative procurement affect defence spending efficiency, as measured by waste reduction.
2. Country-specific analysis: separate scenarios were generated for Italy, Spain, Sweden, and Portugal to provide insights into how these countries would benefit individually from increasing their European collaborative procurement ratios.
3. EU23 counterfactual: given that many Member States either had missing or zero EU collaborative procurement ratios, a counterfactual scenario was constructed. This scenario aimed to simulate the potential waste reduction that could be achieved if these countries adopted collaborative procurement practices similar to those of Italy, Spain, Sweden, and Portugal. The assignment of behavior was based on the size of defence equipment procurement expenditures across Member States.

EU14 Analysis

In the first analysis, we applied a time series regression model to the EU14 group. The estimated coefficient of (-26.2755) indicated that for each 1 % increase in the collaborative procurement ratio, waste was predicted to decrease, on average, by approximately €26.3 million. The scenarios were structured, as previously, following increases from 5 % to 30 % in collaborative ratio. To estimate the relationship between changes in waste when changing the EU collaborative ratio, a time series regression model was estimated, as presented in the previous section. The results are presented in Table 16 and Figure 5.

Table 16 – Predicted waste reduction under different EU collaborative ratio increase scenarios for EU14

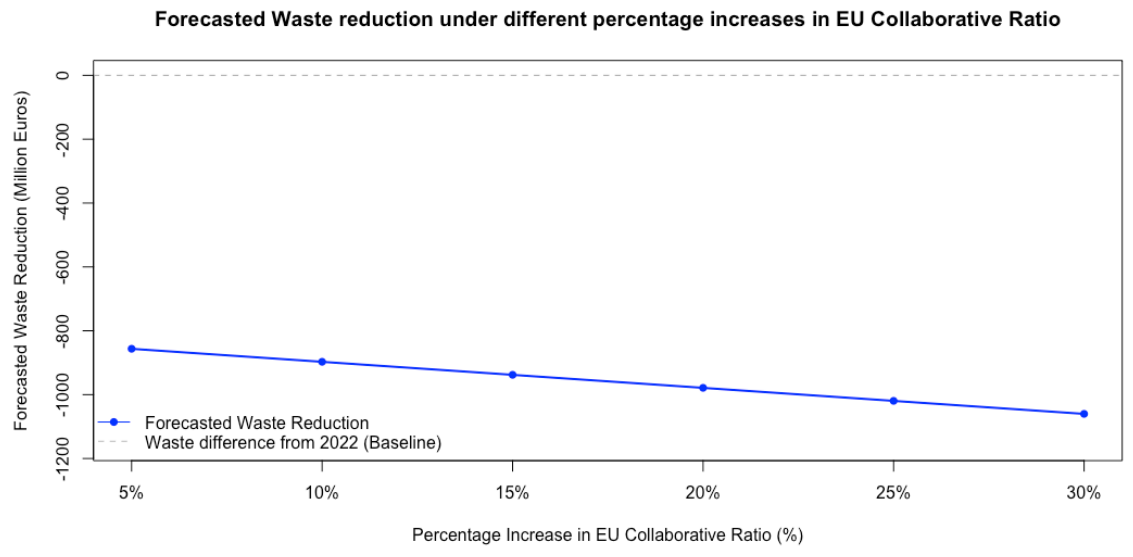
Increases in EU collaborative ratio		Predicted waste reduction (million €)
Percentage change	Value (%)*	
5 %	32.59	-856.35
10 %	34.14	-897.13
15 %	35.70	-937.91
20 %	37.25	-978.69
25 %	38.80	-1019.46
30 %	40.35	-1060.24
Estimated coefficient	$\beta = -26.275$	

*the baseline value for the EU collaborative ratio is the value from 2022, of 31.039 %.

Source: Authors' estimations.

At 5 % increase in collaborative ratio, the predicted waste reduction is of €-856.4 million. This moderate reduction demonstrates some immediate savings benefits. For a 10 % increase, a waste reduction of -€897.1 million is estimated. This indicates that a more substantial collaborative procurement could lead to higher efficiency (waste reduction) gains over time. Progresively, the waste reduction becomes larger as the collaborative ratio increases, surpassing €1 billion for a 30 % increase in collaborative ratio.

Figure 5 – Predicted waste reduction under different collaborative procurement scenarios for EU14



Source: Authors representation.

This analysis demonstrated that increasing the EU collaborative procurement ratio consistently reduces waste across the EU14 group. The results showed a linear relationship, with larger increases in collaborative procurement leading to progressively larger waste reductions.

Analysing the relationship between waste and EU collaborative procurement ratio for Italy, Spain, Portugal and Sweden ensures the analysis captures a broader spectrum of Member States, particularly those that might have different strategic priorities or face different economic constraints. These countries show varying levels of engagement in collaborative procurement, from high involvement to moderate and lower levels. This variation is important to understanding how different levels of collaborative engagement influence the potential savings and efficiencies gained from waste reduction. Focusing on countries with different levels of collaborative procurement helps to identify the factors that contribute to higher or lower savings potential under different waste reduction scenarios.

Table 17 – Predicted waste reduction under different EU collaborative ratio increase scenarios for Italy, Portugal, Spain and Sweden

	Italy* (2005-2022)***		Portugal** (2005-2022)***		Spain* (2013-2022)***		Sweden** (2007-2022)***	
Perc. change	Increases in EU collab. ratio (%)	Pred. waste red. (million €)	Increases in EU collab. ratio (%)	Pred. waste red. (million €)	Increases in EU collab. ratio (%)	Pred. waste red. (million €)	Increases in EU collab. ratio (%)	Pred. waste red. (million €)
5 %	40.85	-132.86	1.53	-6.69	44.96	-113.94	5.93	-121.83
10 %	42.80	-139.19	1.61	-7.04	47.10	-119.36	6.22	-127.79
15 %	44.74	-145.51	1.68	-7.34	49.24	-124.79	6.50	-133.54
20 %	46.69	-151.84	1.75	-7.64	51.38	-130.21	6.78	-139.29
25 %	48.63	-158.17	1.83	-7.99	53.52	-135.64	7.06	-145.05
30 %	50.58	-164.49	1.90	-8.31	55.66	-141.06	7.35	-151.01
Estimated coefficient	$\beta = -3.25$		$\beta = -4.37$		$\beta = -2.53$		$\beta = -20.54$	

*the baseline value is the EU collaborative ratio in 2022: 38.91 % for Italy, 42.81 % for Spain.

**the baseline value is the average EU collaborative ratio for 2005-2022: 1.46 % for Portugal, 5.65 % for Sweden.

***the periods specified for each country represents the period for which the regression equation was estimated. For Spain and Sweden, the periods are shorter because the series presented break points; the periods with the most stability – after the break point – were chosen to estimate the relationship between waste and ratio.

Source: Authors' estimations.

These country-specific results highlight that the impact of increasing the collaborative procurement ratio varies significantly between Member States. While Italy, Spain, and Sweden benefit from relatively large reductions in waste, Portugal's potential for waste reduction appears more limited. This suggests that different countries may have varying capacities to optimise defence spending

through collaborative procurement, based on the current state of their defence procurement practices.

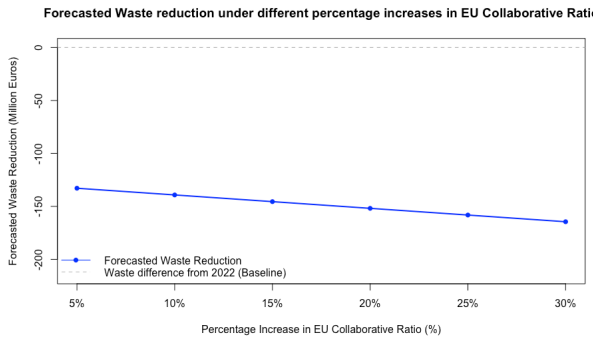
The country analysis underscores the significant potential for cost savings and increased efficiency in defence procurement (waste reduction measures) across the EU through targeted collaborative procurement engagement. The findings advocate for more aggressive strategies to maximise efficiency gains (waste reduction), enhance collaborative procurement, and strengthen the overall defence capabilities of the EU.

EU23 counterfactual scenarios

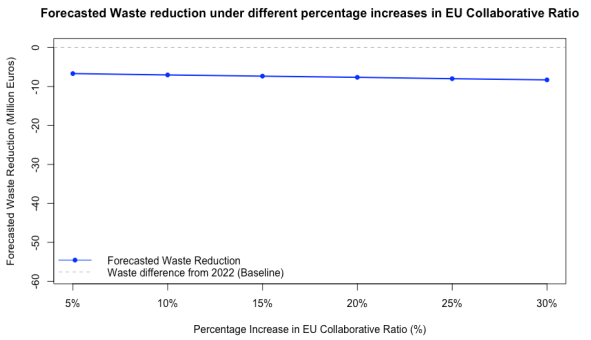
Since there is a significant number of countries with either non-reported data or with zero ratio, we built a counterfactual scenario for the EU23 countries for whom we estimated model 2 (we excluded AT, CY, IE and MT, as being outliers). This allowed for an estimation of the potential waste reduction that could be achieved if more Member States adopted similar collaborative procurement strategies.

Figure 6 – Predicted waste reduction for Italy, Portugal, Spain, Sweden (5 %-30 % increased EU collaborative ratio)

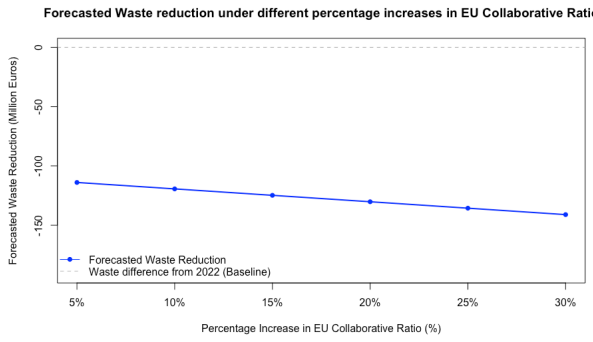
Italy



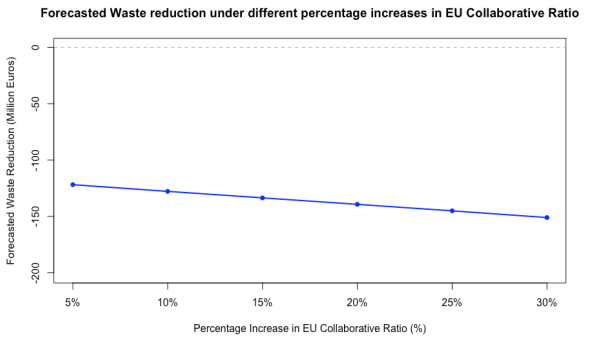
Portugal



Spain



Sweden



Source: Authors representation.

We assigned the behaviour in terms of the EU collaborative ratios of Italy, Spain, Sweden and Portugal to the other countries, according to the distribution of the defence equipment procurement expenditure, as presented in Table 18.

Table 18 – Description of the counterfactual

	Portugal	Sweden	Spain	Italy
Defence equipment procurement (million €)	621	1 677	3 185	5 923
MS with lower level of defence procurement*	SI, LV, EE, LU, BG, HR, SK, LT	CZ, RO, BE, DK, HU	FI, NL	EL, PL, FR DE

*The correspondence of MS is based on the comparison between the (1) MS level of defence equipment procurement and (2) the level of defence equipment procurement among the four Member States for which we made the estimation.

In constructing the counterfactual scenario for the EU23, we chose Italy, Spain, Sweden, and Portugal as reference countries for several strategic and analytical reasons. These countries were selected based on their diverse defence procurement profiles, their varying levels of collaborative procurement involvement, and their representativeness across the spectrum of Member States in terms of defence spending, allowing for a more robust and realistic application of collaborative procurement behaviour across the EU23. Italy has one of the highest levels of defence equipment procurement expenditure within the EU, amounting to €5.9 billion. This ensures that high-expenditure Member States have a relevant model for collaborative procurement practices. Spain, with €3.2 billion in defence equipment procurement, represents the medium-high expenditure tier among EU countries. Sweden, with €1.7 billion in defence equipment procurement, provides a reference for countries with medium procurement levels. This is important for understanding how collaborative procurement can optimise spending for countries like Belgium, Denmark, and Hungary, which fall into this expenditure range. Portugal, with €621 million in defence procurement expenditure, represents the lower tier of defence spending among EU countries. This makes Portugal an ideal reference for smaller Member States with lower levels of defence procurement, such as Slovenia, Latvia, and Estonia. Using Portugal as a reference ensures that the counterfactual applies to smaller countries with more limited defence budgets, providing insights into how they can still benefit from collaborative procurement.

Additionally, Italy, Spain, Sweden, and Portugal have demonstrated differing levels of engagement with EU collaborative procurement, providing a well-rounded mix of behaviours for the counterfactual scenario. These countries are recognised for their active involvement in collaborative defence procurement initiatives, but they differ in terms of scale and intensity, reflecting a broad spectrum of collaborative procurement practices. Italy's large defence procurement budget and its active participation in several EU collaborative procurement projects make it a key reference for high-expenditure countries seeking to further optimise their defence spending through collaboration. Spain is another prominent player in EU collaborative procurement, with a moderate but consistent commitment to joint defence initiatives. It serves as a useful benchmark for countries aiming to strike a balance between national procurement and EU-wide collaboration. Sweden has been an early adopter and advocate of collaborative defence procurement within the EU, particularly in the areas of research, development, and acquisition. Sweden's role as a reference provides valuable insights into how medium-expenditure countries can maximise the benefits of collaborative procurement. Portugal, despite having a smaller defence budget, has consistently shown commitment to EU-wide defence collaboration. Portugal's involvement provides a realistic model for smaller Member States looking to leverage collaborative procurement to optimise their limited defence resources.

The selected countries provide a good geopolitical and strategic balance within the EU, representing both northern and southern Europe, as well as different geographic and security concerns. This ensures that the counterfactual model accounts for diverse regional contexts and security needs across the EU. Italy and Spain represent southern Europe, where geopolitical concerns may differ from those in northern Europe, particularly regarding Mediterranean security and NATO engagement. These countries provide valuable insights into how southern European states can enhance their defence collaboration. Sweden represents northern Europe, offering a perspective on how collaborative procurement can benefit states that are more focused on security issues in the Baltic and Arctic regions. Portugal represents the south-western edge of the EU, providing insights into how smaller countries with Atlantic security concerns can benefit from defence collaboration.

Italy, Spain, Sweden, and Portugal were selected as reference countries for the counterfactual analysis due to their diverse defence procurement profiles, varying levels of engagement in EU collaborative procurement, and their strategic representativeness across the EU. This approach allows for a realistic and balanced application of collaborative procurement behaviours to the EU23, providing valuable insights into how other Member States can enhance their defence spending efficiency through increased collaboration (Table 19 and Figure 7).

Table 19 – Predicted waste reduction under different EU collaborative ratio increase scenarios for EU23 counterfactual, comparative with EU14

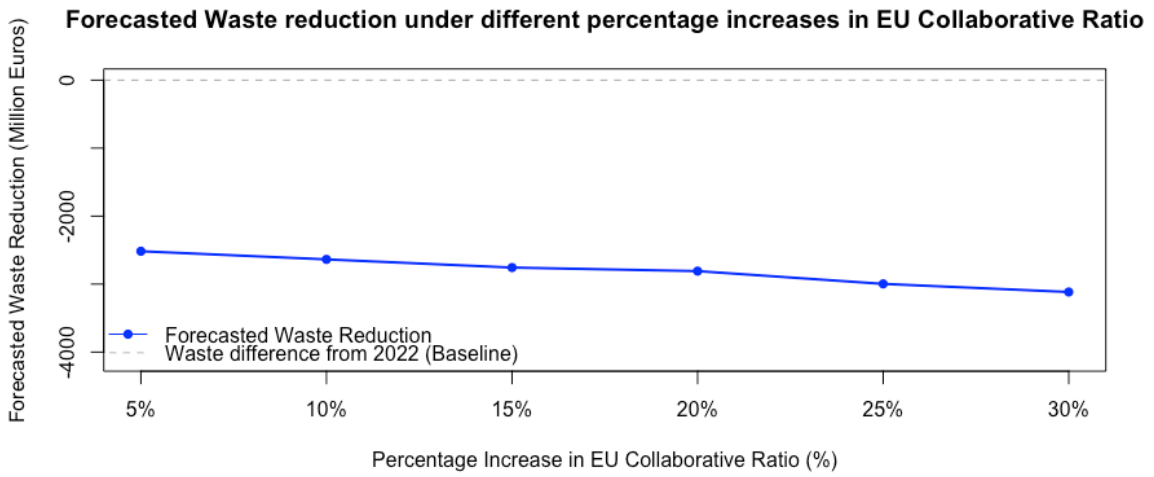
Increases in EU collaborative ratio			Predicted waste reduction EU14 (million €)	Predicted waste reduction EU23 counterfactual (million €)
Percentage	Value (%) EU14	Value (%) EU23 counterfactual*		
5 %	32.59	26.95	-856.35	-2516.751
10 %	34.14	28.23	-897.13	-2636.285
15 %	35.70	29.52	-937.91	-2756.753
20 %	37.25	30.80	-978.69	-2876.287
25 %	38.80	32.09	-1019.46	-2996.755
30 %	40.35	33.37	-1060.24	-3116.289
Estimated coefficient	$\beta = -93.38$			

*The baseline value is the maximum collaborative ratio for the counterfactual scenario (25.6 %). The period used is 2010-2022, which showed more stability, with no breaking points, which is needed to estimate the relationship between waste and ratio.

Source: Authors' estimations.

The estimated coefficient for this counterfactual scenario was -93.38, indicating that each 1 % increase in the collaborative ratio would reduce waste by €93.4 million. The waste reduction results vary from -€2.5 billion at a 5 % increase in collaborative ratio to -€3.1 billion at a 30 % increase.

Figure 7 – Predicted waste reduction under different collaborative procurement scenarios for EU23 counterfactual



Source: Authors' representation.

The counterfactual scenario highlights the significant potential for waste reduction if more Member States adopt collaborative procurement strategies similar to those of Italy, Spain, Sweden, and Portugal. The larger waste reductions in this scenario reflect the fact that many of the countries in the EU23 have room for improvement in their defence procurement practices, and aligning their procurement behaviours with more efficient Member States could yield substantial savings.

The scenarios developed for enhancing EU collaborative procurement demonstrate the significant potential for reducing waste in defence spending across the EU. The results indicate that increasing the collaborative procurement ratio has a strong, positive impact on reducing inefficiencies, both for individual countries and for the EU as a whole. The country-specific analyses show that while some Member States, such as Italy and Sweden, stand to benefit significantly from increased collaboration, others, such as Portugal, may see more modest gains. The counterfactual scenario for the EU23 underscores the importance of expanding collaborative procurement practices across the entire EU, particularly for countries that have not yet adopted these practices.

5.3. Enhance joint procurement in defence sector

In times of crisis, joint procurement of public goods to serve the interests of citizens becomes essential. Faced with repeated crises, the EU has turned to joint public procurement (vaccinations during the pandemic, reducing energy bills for vulnerable citizens, and helping Ukraine during the war (Ostanina & Tardy, 2024). The use of joint procurement generates numerous benefits: reducing costs, creating economies of scale, promoting interoperability, strengthening bargaining power and avoiding unnecessary competition between MS (Britz, 2023). In the defence field for a long period until the invasion of Ukraine, Member States promoted low production, under-investment, market fragmentation and slow technological advance. Faced with the challenges of war, the EU has promoted a number of common defence mechanisms: the Common Procurement Act (EDIRPA), the three-track approach of the European Peace Facility (EPF) and the broader European Defence Agency (EDA) efforts in this area (Perot, 2023). However, while the stated objective remains a

common action for the development, procurement and operation of military equipment, in practice, the implementation of this objective can be fraught with difficulties (Bátora & Fossum, 2023).

Faced with the need for military equipment, EU states can choose in the short term between two courses of action: either to rapidly increase the EU's production capacity by developing their own industrial bases, or to buy military goods 'off the shelf', increasing dependence on third countries (Zandee, 2022). On the other hand, expanding joint procurement and buying European goods would mean eliminating dependence on external nations, increasing EU competitiveness and minimising market fragmentation (Besch, 2023).

Prior to the invasion of Ukraine, joint procurement of military equipment is in a nascent position in 2021, but still on the rise at €8 billion (18 % of total military equipment spending). However, the target of 35 % was only half reached. The reason for this under-allocation is either countries' traditional retention of authority over their own defence policy decisions or insufficient financial allocations for long periods, even though NATO has a 2 % GDP target.

However, despite being formulated in legislation, EDIRPA is still hardly working in practice, prolonging the shortcomings of the European armaments market: the fragmentation of the supply chain and the defence industry's dependence on external parties. Faced with the absence of coordination and planning, Member States have resorted to individual and ad hoc solutions: the acquisition of military equipment with third states (Germany, Poland, Romania, Greece for F-35 aircraft with the US, and Poland and Romania for self-propelled artillery with South Korea).

The inability of European states to communicate with each other and to overcome financial losses due to achievable economies of scale are two recent examples of critical shortcomings in defence capabilities that have been highlighted in EU documents. These documents emphasise the need for the EU to spend more collectively, more efficiently and in a European way, and the importance of cooperative efforts in procurement and delivery (Hartley, 2023).

In these conditions, we present below an analysis of the possible savings that could be achieved by the Member States, if joint procurement within the EU were to be realised (Table 20). The illustrative case is the purchase by different states of F-35 aircraft from the USA. Our scenarios assume the following: first scenario, obtaining a price/airplane similar to the one obtained by Finland; second scenario, obtaining a price/airplane similar to the one obtained by Poland (the state that obtained the lowest price).

It is worth noting that if they had acted jointly, the MS would have bought at least 261 F-35 airplanes, which is the second largest order after the US military. Under these conditions, with increased bargaining power, the price obtained could have been even lower. If the purchase price had been similar to that of the Finland, the Member States would have obtained savings of €10.3 billion, and in the second scenario (Poland) savings of €7.1 billion.

Joint European spending on defence research and development is increasing compared to previous years, but is still below the 20 % target for the EU R&D collaborative. If European states had fulfilled their previous R&D obligations, the defence industrial base would be stronger and more competitive. The second reason is the maintenance of a strong US position in European defence policy. European states depend overwhelmingly on US support in the military field, both for military equipment and for military organisation and leadership. This analysis evaluates potential savings for EU countries if they collectively acquire F-35 aircraft from the USA, using the prices paid by the Finland and Poland as reference points. The data compares the contract values, per-aircraft costs, and potential savings

for different EU countries under two scenarios: scenario 1: Using the price paid by the Finland; scenario 2: Using the price paid by Poland.

Table 20 – F-35 acquisition (supplier USA) savings under common EU acquisition (1 with the price for UK and 2 with the price for Denmark)

Country	Number Ordered	Value contract (million €)	Value per aircraft (million €)	Savings using price for Finland (million €)	Savings using price for Poland (million €)
Belgium	34	6530	192.058	2067.472	1642.472
Czechia	24	4570	190.416	1419.984	1119.984
Finland	64	8400	131.25	0	-800
Greece	40	8600	215	3350	2850
Germany	35	5400	154.285	806.225	368.725
Poland	32	4600	143.75	400	0
Romania	32	6500	203.125	2300	1900
Total	261	44600		10343.68	7081.181

Source: Own elaboration based on EDA, NATO and SIPRI data.

The total potential savings across all countries are significant: using Finland's price as the benchmark, the total savings amount to approximately €10.3 billion; using Poland's price, the savings are slightly lower but still substantial at approximately €7.1 billion. Some considerations need to be made with country-specific insights. Belgium, Czechia, Greece and Romania show high potential savings, indicating that they paid significantly higher prices per aircraft compared to the UK and Denmark. Finland also shows considerable savings, but their current prices per aircraft are relatively low compared to others like Belgium and Romania. Poland and Germany have room for substantial savings, indicating that their procurement prices were higher than those negotiated by the UK and Denmark.

At EU27 level however, a common EU acquisition of defence equipment will face many challenges and considerations, such as: implementing a common acquisition strategy requires careful coordination and negotiation among Member States to align procurement timelines, budget allocations, and strategic priorities; ensuring that the procured assets meet the diverse operational requirements and strategic contexts of different countries will be essential; achieving consensus among Member States for joint procurement initiatives involves overcoming political and bureaucratic hurdles, as well as addressing concerns over sovereignty and national defence autonomy.

Procuring military equipment from the US in a collaborative manner offers several strategic, operational, and economic advantages for Member States. While European countries typically emphasise strengthening their own EDTIB, there are compelling reasons for Member States to jointly procure military equipment from the US. As strategic and operational advantages, NATO compatibility and unified defence capabilities can be mentioned. Many Member States are also members of NATO, an alliance where the US plays a pivotal role. Procuring US military equipment

ensures compatibility and interoperability among allied forces, which is critical for joint operations, training, and missions. Collaborative procurement of US equipment ensures that Member States maintain a standardised level of defence capability, reducing gaps in military effectiveness and enhancing collective security.

Considering the access to advanced technology, the US is a global leader in defence technology. Procuring US military equipment collaboratively allows Member States to access state-of-the-art technology, such as advanced fighter jets, missile systems, and cyber defence tools. Joint procurement enables EU countries to modernise their armed forces more rapidly by pooling resources and securing the latest technology, which may not yet be available within the EU. Collaborative procurement from the US reinforces transatlantic defence ties, demonstrating solidarity and a shared commitment to collective security. This could strengthen political and military relations between the US and EU. By aligning their military procurement with the US, Member States may benefit from implicit or explicit security guarantees, enhancing their national security and defence posture.

By pooling resources, Member States can co-invest in R&D for new military technologies and systems, sharing the financial burden and reducing the overall cost of innovation. Collaborative R&D efforts with US defence firms can lead to accelerated development and deployment of new technologies, keeping EU armed forces at the forefront of military innovation.

Procuring the same equipment allows Member States to maintain common platforms, reducing logistics, maintenance, and spare parts inventory costs. It simplifies supply chain management and enhances operational readiness. Joint procurement enables the development of unified training programs for military personnel across EU countries, fostering greater cooperation, knowledge sharing, and operational coherence.

Another line for possible involvement of enhancing joint procurement could be the acquisition for self-propelled artillery. On the market for self-propelled artillery there are three major competitors: two from EU (CAESAR/AMX 30 AuF1 from France and PzH-2000 from Germany) and one from South Korea (K9 Thunder), various EU countries acquire different self-propelled howitzers from different countries (Table 21).

Table 21 – Self-propelled howitzers acquirement

K9 Thunder	Number ordered	Value contract (million €)	Value per equipment (million €)
Poland	212	2400	11.32
Romania	54	920	17.03
Norway	24	230	9.58
CAESAR/AMX 30 AuF1	Number Ordered	Value contract (million €)	Value per equipment (million €)
Belgium	28	110	3.92
Czechia	52	200	3.84
Denmark	15	40	2.66

K9 Thunder	Number ordered	Value contract (million €)	Value per equipment (million €)
Estonia (through collaborative procurement)	12	30-40	2.5 to 3.3
France (through collaborative procurement)	110	350	3.18
Croatia (through collaborative procurement)	18	54-65	3 to 3.5
Lithuania	18	110	6.11
PzH-2000	Number ordered	Value contract (million €)	Value per equipment (million €)
Germany	10	184	18.4
Italy	70	500	7.1
Lithuania	21	58.3	16
Hungary	24	565	23.5
Netherlands	56	250	4.5

Source: Own elaboration based on EDA, NATO and SIPRI data.

A simulation showing the cost efficiency if countries had procured the CAESAR artillery system instead of K9 Thunder or PzH 2000 is made. Table 22 outlines the potential savings for each country, demonstrating that switching to CAESAR could have resulted in significant cost reductions for all of the countries involved.

Table 22 – Estimated savings under the scenario of aquiring CAESAR artillery system

Country	Weapon bought	Number ordered	Value contract (million €)	Value per unit (million €)	Cost if acquiring CAESAR (million €)	Savings (million €)
Germany	PzH 2000	10	184	18.4	31.8	152.2
Italy	PzH 2000	70	500	7.14	222.6	277.4
Lithuania	PzH 2000	21	583	16	66.78	516.22
Hungary	PzH 2000	24	565	23.54	76.32	488.68
Netherlands	PzH 2000	56	250	4.45	178.08	71.919
Poland	K9 Thunder	212	2400	11.32	674.160	1725.84
Romania	K9 Thunder	54	920	17.04	171.72	748.28
Norway	K9 Thunder	24	230	9.58	76.320	153.68

Source: Authors' estimations.

Based on the simulation provided, procuring the CAESAR artillery system through collaborative mechanisms like EDIRPA would lead to significant cost savings for several countries that opted for the K9 Thunder or the PzH 2000.

The countries that opted for the K9 Thunder and PzH 2000 invested significantly more per unit compared to what they would have spent had they procured the CAESAR system. For instance, Poland, which ordered 212 units of K9 Thunder at a contract value of €2.4 billion, could have saved €1.7 billion by opting for CAESAR instead, reducing the contract value from €2.4 billion to just €674.2 million; Romania would have saved €748 million had they chosen CAESAR instead of the K9 Thunder, cutting their total contract value from €920 million to €171.7 million; Hungary, which ordered 24 PzH 2000 units at a contract value of €565 million, could have saved €488.68 million, reducing the overall contract to just €76.3 million by choosing CAESAR. This simulation highlights that, across the board, CAESAR would have provided substantial cost reductions without compromising on the core capabilities required for modern artillery systems.

The EDIRPA mechanism is essential for optimising defence budgets, especially in the context of collaborative procurement. By pooling resources and opting for a common platform like CAESAR, countries can reduce individual procurement costs. The simulation clearly shows that the collaborative procurement of CAESAR offers a more cost-efficient solution while promoting greater interoperability between Member States. For example, Estonia and Croatia, which participated in collaborative procurement under EDIRPA, benefitted from much lower costs per unit for CAESAR systems, demonstrating the success of this approach.

In addition to cost savings, opting for CAESAR instead of foreign-produced systems like the K9 Thunder (South Korean) or the PzH 2000 (German) supports the EDTIB. The Nexter-manufactured CAESAR is a product of the European defence sector, ensuring that defence budgets are reinvested into the local economy, strengthening the EU's defence production capabilities.

The CAESAR system emerges as a highly efficient and strategically sound choice for procurement through the EDIRPA mechanism. Its lower cost, mobility, and the fact that it is produced within Europe make it an ideal candidate for enhancing EU defence capabilities. Moreover, the collaborative procurement approach under EDIRPA not only supports greater interoperability across Member States but also ensures the sustainability of the European defence industry, making it the most efficient way to strengthen Europe's defence infrastructure.

6. Conclusions

The purpose of this paper is to determine how operating defence strategies at the national level, as opposed to the European level, has a cost – or that there is a 'non-European' cost. The main cause of this expenditure is the lack of integration of Member States' military structures. European armed forces continue to be strictly national, although they routinely participate in multi- or international armed contingents. Just as most weapons and equipment are purchased at the national level, personnel are trained and maintained by their Member State. The 'standalone' strategy creates vulnerability and will inevitably increase the cost of creating, maintaining, and managing armed forces in Member States. The absence of a fully integrated market is the second factor leading to expenditure. Competition is hindered, and economies of scale are lost in industry and production due to the existence of 27 segregated national defence markets, each with its own administrative burden and independent regulations.

Since the conclusion of the Cold War, governments have profited greatly from the peace dividend; yet, they have neglected to make arrangements for the termination of this benefit. They are at this time ill-prepared to raise defence spending, and many are finding it extremely difficult to do so. 2024 will be a pivotal year for the security architecture of Europe in the future. Russia's danger to NATO members may possibly grow as the war in Ukraine continues. Budgets for defence in 2024 and later will be impacted by additional pressure on Europe to raise defence budgets and military assistance to Ukraine. Defence spending will probably need to stay elevated for a while to maintain peace in a geopolitical situation that is becoming more and more difficult. Given the limited financial resources and the trade-offs in spending, Europe needs to find fiscally sound ways to accomplish this and win over the public.

Initiatives to combine supply and demand may result in significant savings, or in a more effective defence for the same amount of investment, given the fragmentation of defence expenditure and manufacturing across the EU.

Using the DEA technique, we estimate the amount of waste that currently exists in the European defence landscape in this area. We perform two exercises. First, we look at a model where the output for 2005–2022 is the number of troops deployed and the input is defence spending per capita. Second, we used the procurement of military equipment as input and R&D spending as output to represent the future quality of equipment for 2005–2022.

We get a total waste of almost €45 billion in the first exercise using the base model. The robustness tests, where we change the definition of inputs/outputs, also show similar numbers.

Based on our defence models, larger countries appear more efficient than smaller ones on average, and our technique indicates the existence of increasing returns to scale in most countries' production functions. It is therefore highly likely that efficiency gains could be made if the EU's unified spending on military deployment were sounder. The main findings for the second exercise, which involved military procurement and research and technology, are: (i) Member States are generally far from the efficient frontier; (ii) larger countries consistently out-perform smaller countries in terms of efficiency; (iii) total waste is slightly more than €10 billion; and (iv) most countries show increasing returns to scale.

Increasing the number of deployed troops offers substantial benefits for both individual Member States and the EU as a whole. For EU Member States, it enhances national security, operational experience, and international partnerships. For the EU, it strengthens collective defence capabilities,

crisis response readiness, and strategic autonomy. Together, these advantages contribute to a more secure, cohesive, and influential European Union on the global stage.

We explore different policy scenarios aimed at enhancing the defence outcomes of Member States through improved military operational capability and procurement strategies, by building scenarios around waste reduction.

First, we looked at the enhancement of troop deployment. Across the various scenarios, there is a consistent negative relationship between waste and the percentage of deployed troops in total armed forces. As percentage of deployed troops increases, waste decreases. This finding suggests that improving efficiency in defence spending enables more effective allocation of resources, leading to less waste.

Second, we looked at the enhancement of the collaborative procurement ratio within the EU in the defence sector. The analysis of the six scenarios reveals significant insights into the potential benefits of targeted policy interventions in defence procurement. Increasing collaborative procurement among Member States leads to reduced waste, offering several advantages, including cost savings through economies of scale, enhanced interoperability, and a unified defence posture. By leveraging joint procurement strategies within the EU, Member States can reduce costs, improve operational capabilities, and strengthen collective defence efforts. This approach fosters closer integration of European defence capabilities, supporting the EU's long-term goal of strategic autonomy.

Third, we considered joint procurement in the defence sector. Procuring military equipment jointly from the US when there is no EU alternative presents an opportunity for Member States to access cutting-edge technology, ensure interoperability with NATO forces, and leverage collective bargaining power for better pricing and terms. By combining their orders, Member States can achieve significant economies of scale, reducing the per-unit cost of advanced military equipment. This strategy not only enhances individual and collective defence capabilities but also offers substantial financial savings and improves the cost-effectiveness of defence spending. Additionally, joint procurement strengthens transatlantic defence ties, fostering a closer partnership with the US while allowing EU countries to benefit from the US defence industry's economies of scale.

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APPENDIX – Supplementary analysis on defence spending for the Member States

I. Descriptive analysis of main defence indicators

A comparative analysis of the main indicators related to military indicators are presented in Table 23. As can be seen, public defence spending as a percentage of GDP has significant differences for the period 2005-2022: for the EU27, it was extremely low 1.19-1.32 in the 2005-2016 interval. After the adoption of European policies in the field of defence to increase slightly to values of 1.43-1.57. In contrast, the UK has values higher than 2% throughout the period, and the USA in the range of 3.4-4.3. another important indicator to analyze, defence procurement has different values between the categories of countries: for the EU, the average of the period is 500, but instead for the USA it is more than 5 times higher.

Table 23 – Averages for the main defence indicators for EU27, UK and USA, in the period 2005-2022

Period/ Country		Total Defence Expenditure (bn. euro)	Defence Expenditure as % of GDP	Defence Expenditure per capita (euro)	Armed forces (number)	Defence Investment (bn. euro)	Defence Equipment Procurement Expenditure (bn. euro)	Defence R&D Expenditure (bn. euro)	Average Number of Troops Deployed (number)
2005-2013	EU27	1399,98	1,326	287,157	83669,8	262621,4	214,96	48,52	1935
	UK	405,54	2,262	724,009	183748,8	97755,3	69,26	28,49	13277
	USA	4764,34	4,355	2008,111	1527279,2	1671538,9	1194,18	477,35	329643
2014-2016	EU27	461,65	1,199	284,265	74622,8	77640,9	63,94	13,70	1173
	UK	152,19	2,092	779,037	161000	33977,6	22,42	11,55	2335
	USA	1660,43	3,588	2020,719	1435533,3	615121,1	422,51	192,60	194658
2017-2021	EU27	953,34	1,430	371,759	71345,4	207430,9	172,81	34,61	1344
	UK	289,58	2,199	884,104	149610	76442,4	56,77	19,67	5305
	USA	3157,99	3,443	2050,037	1364500	1196418,5	890,57	305,84	173174
2022	EU27	239,16	1,575	486,249	70184,6	58429,2	48,45	9,96	1557
	UK	71,93	2,162	950,246	153000	20232,5	15,92	4,30	8000
	USA	782,69	3,449	2169,194	1395000	295356,1	213,12	82,23	228390
2005-2022	EU27	3054,49	1,340	321,424	77855,2	606168,2	500,22	106,80	1606
	UK	919,27	2,211	790,220	168766,1	228408	164,38	64,02	8946
	USA	10365,46	3,923	2030,807	1459422	3778434	2720,39	1058,04	258057

Source: Authors' calculation.

Table 24 presents the defence expenditures as a nominal value in euros during the analyzed period, 2005-2022. As can be seen, two countries (France and Germany) stand out with the highest military expenditures during this period, with values of over €350 billion. Two other countries, Spain and Italy, also present important values of over €100 billion throughout the period, and Poland and the Netherlands in 2017-2022. In general, however, the values for the other countries are within narrow limits (below 50 billion), and for small countries (Slovenia, Malta, Luxembourg, Lithuania, Latvia,

Estonia, Cyprus) even below 10 billion. Regarding the study periods, significant differences can be observed here as well. In the period 2005-2013 (post cold war), defence spending was at a low level for all states, as a result of the 'peace dividend'. In the period 2014-2016 (after the annexation of Crimea), the states of Western Europe significantly reduce the level of public spending, but the Eastern European states start to increase their level. The moment of 2016, together with the adoption of European policies in the field of defence (PESCO), leads to the assumption by all states of some commitments and thus to the sustained increase of defence expenditures. The moment of 2022 (the invasion of Ukraine) makes all European states reach historical highs for military spending after the Cold War.

Table 24 – Average defence spending by EU countries across different time periods (in million €)

Country	2005-2013	2014-2016	2017-2021	2022
Austria	2398.385	2542.877	2979.234	3447.100
Belgium	3882.653	3871.482	4506.986	6516.000
Bulgaria	636.079	587.955	1114.669	1269.000
Croatia	639.339	590.399	872.055	1244.000
Cyprus	317.843	283.940	409.635	506.290
Czechia	1914.383	1639.559	2593.413	3698.766
Denmark	3317.378	3075.633	3645.460	4618.000
Estonia	264.872	417.867	562.028	779.500
Finland	2590.246	3035.070	3701.445	5163.000
France	41222.111	39449.086	44372.248	49700.000
Germany	32605.029	36081.921	46666.670	58266.247
Greece	5164.441	4088.041	4901.685	8054.000
Hungary	1103.106	1032.303	1883.106	3099.470
Ireland	941.059	894.390	988.862	1107.000
Italy	22573.083	18765.217	22717.611	28757.000
Latvia	239.632	280.272	612.774	813.000
Lithuania	280.839	440.439	946.090	1647.000
Luxembourg	177.478	209.503	326.473	464.000
Malta	39.678	48.825	64.545	68.940
Netherlands	8204.906	7945.841	10492.646	10800.000
Poland	5906.323	8537.209	10755.692	14585.500

Country	2005-2013	2014-2016	2017-2021	2022
Portugal	2575.387	2416.273	2946.902	3425.700
Romania	1769.864	2252.052	4068.418	4931.221
Slovakia	816.143	848.403	1456.669	1983.400
Slovenia	490.035	378.003	508.553	737.297
Spain	11187.546	9507.187	11395.860	15610.000
Sweden	4299.283	4675.396	5178.604	7872.000
Average	5761.375	5699.820	7061.790	8857.905

Source: Own elaboration based on EDA and NATO data.

Table 25 shows the public defence expenditures per capita. The differences are significant between states and across the periods. What is interesting to point out is the fact that for all EU states, defence expenditures/inhabitant have been increasing steadily over the course of 17 years. Western countries have the highest allocations of over 700 € (Sweden, Luxembourg, Germany, France). Most of the other European countries fall within the range of 300-700 €. The countries with the lowest allocations are Malta, Ireland, Bulgaria and Romania (under 300 €).

Table 25 – Average defence expenditure per capita in Member States

Country	2005-2013	2014-2016	2017-2021	2022
Austria	287.343	294.303	335.467	380.740
Belgium	379.142	352.925	392.510	557.256
Bulgaria	84.105	81.679	159.787	186.085
Croatia	150.170	140.415	216.419	318.335
Cyprus	394.685	333.851	464.714	554.717
Czechia	183.762	155.481	243.212	345.990
Denmark	646.667	606.786	727.927	837.169
Estonia	198.453	317.769	424.437	585.298
Finland	484.706	553.813	669.729	929.199
France	638.529	592.504	656.322	725.653
Germany	404.068	441.709	562.038	695.351
Greece	467.114	377.520	457.711	761.390
Hungary	110.178	104.920	193.116	320.078
Ireland	210.985	192.476	200.965	216.435

Country	2005-2013	2014-2016	2017-2021	2022
Italy	380.184	309.083	380.561	487.890
Latvia	112.209	141.988	320.823	431.018
Lithuania	89.426	152.116	337.646	581.363
Luxembourg	355.992	366.997	526.053	708.094
Malta	96.124	109.487	129.375	129.909
Netherlands	496.156	469.012	604.693	610.066
Poland	153.976	222.009	280.560	385.584
Portugal	244.488	233.181	286.319	333.431
Romania	86.265	113.693	209.955	258.959
Slovakia	150.974	156.410	267.209	360.581
Slovenia	240.931	183.204	243.394	349.664
Spain	244.440	204.729	242.351	327.838
Sweden	462.176	476.671	504.202	750.648
EU27 Average	287.157	284.620	371.759	486.250

Source: Own elaboration based on EDA and NATO data.

The most representative indicator and used as an international benchmark is defence expenditure as a percentage of GDP (%). NATO, the main military organization in which most of the MS are present, has established a goal of 2% for the member states, in 2014. In turn, and at the EU level, in 2016, the same threshold of 2% was proposed, but compliance must be voluntary on the part of each MS. As can be seen from Table 26, there are significant differences between the MS for the most important indicator. The country with the highest indicator of 3.87% is Greece. Few countries meet this 2% objective even in war conditions: Poland, Lithuania, Latvia, Estonia (countries that share a common border with Russia). Most of the other EU states show low values overall in the range of 1-2%. However, within the EU states there are also states that present extremely low values below 1% (Austria, Ireland, Malta, Luxembourg). Although 20 out of 27 states are NATO members and there is an obligation to fulfill the 2% percentage, only 4 states have fulfilled this objective. However, positive things also happened during this period. If in the first two analysis periods (2005-2013 and 2014-2016), the MS allocated a decreasing percentage for defence, from 2017 (after the adoption of common policies in the military field), the respective percentage began to increase significantly for 25 from 27 countries (the exceptions being Malta and Ireland) (Cepparulo & Pasimeni, 2024).

Table 26 – Average defence expenditure (%GDP) in Member States

Country	2005-2013	2014-2016	2017-2021	2022
Austria	0.700	0.600	0.600	0.770

Country	2005-2013	2014-2016	2017-2021	2022
Belgium	1.090	0.978	0.964	1.186
Bulgaria	1.802	1.323	1.867	1.501
Croatia	1.378	1.167	1.658	1.858
Cyprus	1.759	1.590	1.908	1.875
Czechia	1.327	0.980	1.191	1.337
Denmark	1.371	1.136	1.282	1.384
Estonia	1.685	2.046	2.090	2.154
Finland	1.383	1.442	1.549	1.936
France	2.098	1.801	1.872	1.881
Germany	1.274	1.187	1.370	1.507
Greece	2.396	2.318	2.756	3.872
Hungary	1.120	0.936	1.339	1.821
Ireland	0.528	0.375	0.282	0.220
Italy	1.424	1.136	1.304	1.506
Latvia	1.199	1.149	2.052	2.081
Lithuania	0.985	1.167	1.959	2.464
Luxembourg	0.467	0.405	0.518	0.594
Malta	0.637	0.519	0.495	0.409
Netherlands	1.330	1.163	1.314	1.147
Poland	1.754	2.019	2.065	2.222
Portugal	1.497	1.348	1.434	1.432
Romania	1.382	1.405	1.895	1.725
Slovakia	1.362	1.076	1.582	1.809
Slovenia	1.400	0.970	1.073	1.250
Spain	1.068	0.883	0.960	1.176
Sweden	1.182	1.042	1.065	1.412
EU27 Average	1.318	1.191	1.424	1.575

Source: Own elaboration based on EDA and NATO data.

Defence investment is another important indicator used to analyze public defence spending. NATO (2014) in a first phase and the European Council (2017) later set an objective for the member states: at least 20% of military expenditures to be allocated to investments. If at the time of 2017, only 8 MS had reached the mentioned level, later there was an improvement in the investments. Collectively, the EU has reached the mentioned level since 2019, and in 2022, the level was 24.2%. The countries with the largest defence investments remain the large European states, which have the biggest defence budgets (France, Germany, Italy). In the context of a nearby war, most states have substantially changed their indicator, experiencing increases of 2-3 times compared to the 2014-2016 period. The smallest allocations for defence investment can be found in Malta, Ireland, Luxembourg, Austria, small states and mainly neutral (Table 27).

Table 27 – Average defence investment in Member States (million €)

Country	2005-2013	2014-2016	2017-2021	2022
Austria	274.534	226.407	234.896	327.900
Belgium	287.698	189.581	516.303	1276.200
Bulgaria	93.150	28.354	355.695	292.000
Croatia	68.572	55.015	115.865	381.370
Cyprus	33.009	13.043	69.057	141.830
Czechia	257.167	186.201	426.827	926.695
Denmark	228.537	379.615	718.177	1303.179
Estonia	63.061	74.632	120.888	229.560
Finland	645.666	539.006	938.319	1931.000
France	10633.556	9758.611	11266.856	14200.000
Germany	5911.871	4585.856	7301.368	10692.918
Greece	1249.288	436.183	955.835	3429.440
Hungary	119.494	108.763	565.260	1474.718
Ireland	79.646	83.572	105.838	118.300
Italy	2593.994	2546.097	4819.631	5985.000
Latvia	24.983	40.065	153.334	199.000
Lithuania	43.862	118.347	292.992	573.650
Luxembourg	40.335	64.750	153.680	248.370
Malta	1.750	1.447	8.358	9.080
Netherlands	1366.312	943.986	3299.163	2167.000
Poland	1231.206	2343.543	3115.532	4789.600

Portugal	268.971	264.207	416.182	624.740
Romania	237.710	424.172	1230.647	1283.723
Slovakia	101.263	128.384	457.297	563.700
Slovenia	55.950	6.777	41.485	165.012
Spain	2060.826	1187.630	2453.302	3319.240
Sweden	1214.535	1180.023	1353.395	1776.000
EU27 Average	1080.998	959.788	1536.525	2164.045

Source: Own elaboration based on EDA and NATO data.

Within the defence investment, an important aspect involves spending on defence equipment. The trend for this indicator is similar to that for defence investment: between 2005-2022 it increases sharply for all MS (Table 28). If in the first two analysis periods, it was at a lower level, after 2017, it experienced significant increases. The countries with the highest levels of equipment procurement are France, Germany, Italy (with over €6 billion), and Poland (€4,7 billion). A category of other medium-sized countries have an indicator of over €1 billion (Sweden, Spain, Romania, Netherlands, Hungary, Greece, Finland, Denmark, Belgium). The state with the lowest allocations remains Malta. The Eastern European states that share common borders with Russia/Ukraine have significantly increased their defence spending, and implicitly equipment procurement, starting with the year 2014. The accelerated acquisition of military equipment is generated by the international tensions in this region and the prioritization general of the security field in these countries (Cepparulo & Pasimeni, 2024).

Table 28 – Average defence equipment procurement in Member States (million €)

Country	2005-2013	2014-2016	2017-2021	2022
Austria	2.427	1.767	5.376	6.165
Belgium	9.005	7.541	9.998	18.210
Bulgaria	0.190	1.926	4.657	6.256
Croatia	0.525	0.234	0.627	0.633
Cyprus	0.000	0.000	0.066	0.392
Czechia	18.520	16.313	16.617	22.436
Denmark	6.600	9.191	17.387	31.551
Estonia	0.815	1.502	3.213	5.070
Finland	34.864	49.969	45.525	44.429
France	3456.444	3132.003	4888.958	6939.850
Germany	1102.076	835.244	1333.524	2281.793
Greece	18.207	0.000	12.470	30.562

Country	2005-2013	2014-2016	2017-2021	2022
Hungary	1.138	0.437	2.626	7.290
Ireland	0.000	0.000	0.050	0.259
Italy	170.483	77.539	61.327	61.647
Latvia	0.141	0.000	1.640	4.877
Lithuania	0.012	0.000	3.310	10.771
Luxembourg	0.143	0.060	1.849	1.283
Malta	0.000	0.000	0.000	0.000
Netherlands	97.235	59.405	126.256	93.015
Poland	89.974	170.940	140.446	85.569
Portugal	5.338	2.368	2.610	3.071
Romania	4.337	1.629	35.056	71.830
Slovakia	3.191	1.624	3.059	2.000
Slovenia	9.116	0.067	1.150	4.208
Spain	191.643	87.607	118.294	133.530
Sweden	168.737	109.284	87.092	98.629
EU27 Average	199.673	169.135	256.414	369.086

Source: Own elaboration based on EDA and NATO data.

Military expenditures for Research and Development represent another important component in the composition analysis (Table 29). The European Council (2017) set an objective of at least 2% of the total defence expenditure for the MS to be realized in a collective European way. In 2017, the percentage was very low (below 1%) so that later, in 2022, it will reach 1.8%. Among the EU states, only the large states (France and Germany) reached the objective, while most of the other countries increased their common R&D expenditures.

Table 29 – Average defence R&D expenditure in Member States (million €)

Country	2005-2013	2014-2016	2017-2021	2022
Austria	272.108	224.640	229.520	321.735
Belgium	230.877	170.086	506.304	1252.346
Bulgaria	92.960	26.428	351.038	285.744
Croatia	68.047	54.782	115.237	380.737
Cyprus	33.009	13.043	68.991	141.438

Country	2005-2013	2014-2016	2017-2021	2022
Czechia	238.647	169.887	410.210	904.259
Denmark	366.101	370.424	700.789	1271.629
Estonia	62.247	73.131	117.675	223.282
Finland	610.802	489.037	892.795	1886.571
France	7177.111	6626.608	6377.898	7260.150
Germany	4809.795	3750.612	5967.844	8411.126
Greece	1231.080	436.183	943.365	3398.878
Hungary	118.356	108.326	562.634	1467.428
Ireland	79.646	83.572	105.788	118.041
Italy	2423.511	2468.558	4758.305	5923.353
Latvia	24.842	40.065	151.694	194.123
Lithuania	43.850	118.347	289.682	562.879
Luxembourg	40.192	64.690	151.831	247.087
Malta	1.750	1.447	8.358	9.080
Netherlands	1269.078	884.581	3172.908	2073.985
Poland	1141.232	2172.603	2975.086	4704.031
Portugal	263.633	261.839	413.572	621.669
Romania	233.372	422.543	1195.591	1211.893
Slovakia	98.072	126.761	454.237	561.709
Slovenia	46.834	6.710	40.335	160.804
Spain	1869.182	1100.023	2335.008	3185.710
Sweden	1045.798	1070.738	1266.303	1677.371
EU27 Average	884.894	790.210	1280.111	1794.706

Source: Own elaboration based on EDA and NATO data.

Table 30 shows the average number of deployed troops in the respective period. The countries with the largest number of soldiers who participated in military missions are France (over 16,000) and Italy (over 8,000).

Some of the other MS have values of the indicator higher than 1000 (Germany, Spain, Romania, Poland, the Netherlands, Greece, Denmark, Belgium) on the other hand, a number of small states (Cyprus and Malta) show values below 10.

Table 30 – Average number of troops deployed in Member States

Country	2005-2013	2014-2016	2017-2021	2022
Austria	1215.333	1274.333	1221.800	670.000
Belgium	1049.000	1007.500	859.200	375.000
Bulgaria	739.125	469.500	155.800	160.000
Croatia	1161.000	183.667	137.000	130.000
Cyprus	4.667	4.000	4.000	4.000
Czechia	1187.444	480.667	349.800	260.000
Denmark	1071.222	442.333	583.800	1070.000
Estonia	220.000	139.667	88.600	100.000
Finland	616.444	508.667	343.800	160.000
France	13821.556	8398.000	13488.000	16420.000
Germany	5298.333	4530.000	3552.000	3597.000
Greece	1184.111	113.333	792.600	1200.000
Hungary	1034.000	811.000	755.000	780.000
Ireland	604.333	454.000	472.000	450.000
Italy	8170.111	6215.000	5473.000	4575.000
Latvia	206.889	118.333	89.800	130.000
Lithuania	265.778	279.000	347.400	550.000
Luxembourg	41.333	35.667	51.000	51.000
Malta	9.333	11.667	9.000	9.000
Netherlands	2587.778	1148.667	626.000	395.000
Poland	3417.333	652.333	2875.000	660.000
Portugal	762.556	477.667	478.600	520.000
Romania	2305.444	851.333	784.000	120.000
Slovakia	604.889	329.000	340.800	390.000
Slovenia	401.333	349.667	264.600	300.000
Spain	3419.778	2050.000	1865.000	2300.000
Sweden	873.222	394.667	304.600	200.000

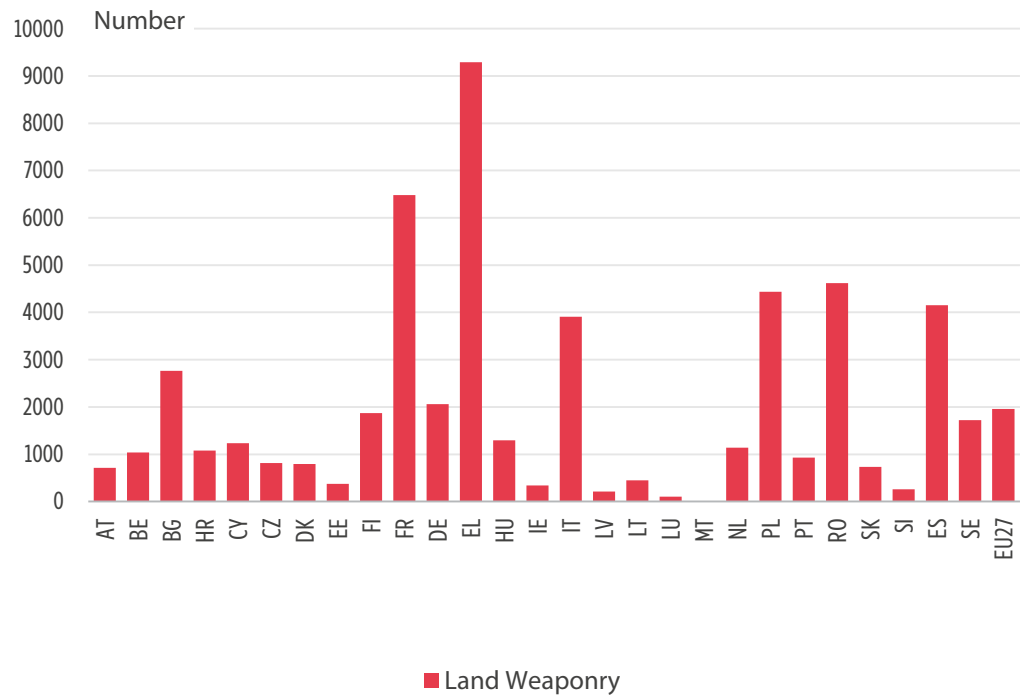
EU27 Average	1936.013	1175.173	1344.896	1317.630

Source: Own elaboration based on EDA and NATO data.

II. Military equipment of EU countries (land/air/naval)

Figure 8 shows the main types of ground weapons belonging to the 27 European member states. As can be seen from the graphic, Greece is the country that has the largest land arsenal among all EU states, in terms of all types of weaponry. The big states (France, Germany, Spain and Italy) also have large arsenals of tanks (over 200), IFV (over 1500), armored vehicles (over 1000). It should be noted that these arsenals are quite new, the respective countries constantly investing in the modernization of the military park. Another category of states, the medium ones (Belgium, Finland, Netherlands, Poland, Romania, Sweden) also have considerable land weaponry resources. Countries with smaller populations have a significantly lower military arsenal. A number of states, especially the former communist ones, have large arsenals, but they mostly are long-standing; now, many of them carrying out extensive procurement programs for new military equipment.

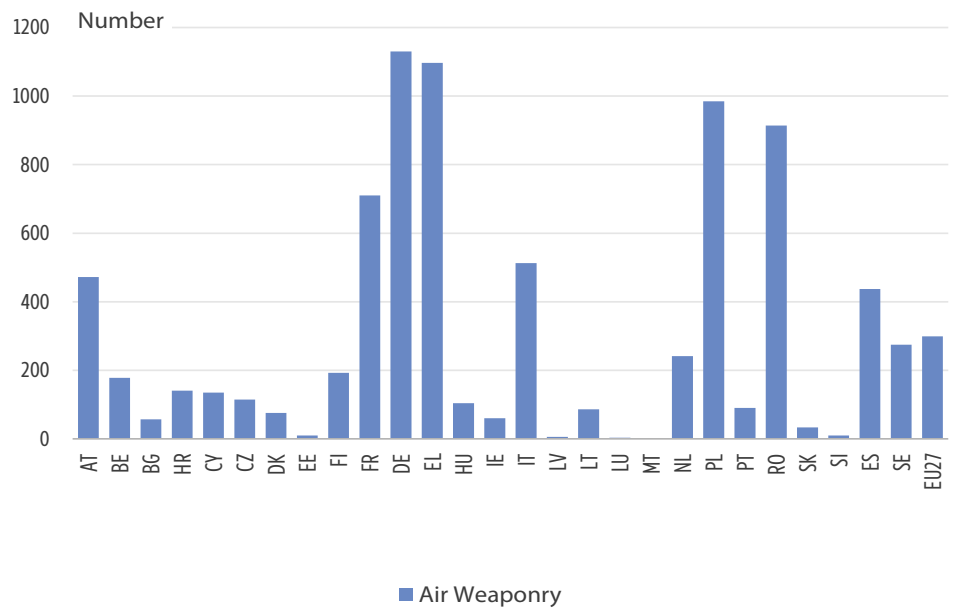
Figure 8 – Military equipment (land weaponry) in Member States



Source: Own estimation based on EDA, SIPRI and NATO data.

The second major segment of military technique refers to air weapons (Figure 9). The largest states and Greece have the highest number of fighter aircraft (over 150), UAVs (over 50), helicopters (over 50). The medium states also have air availability, but lower (under 50 planes, 10 UAVs, 25 helicopters). Smaller states have a low arsenal of the order of a few units. It should be noted that in this segment of armament there is a vast heterogeneity between the types of aircraft and their state of operation.

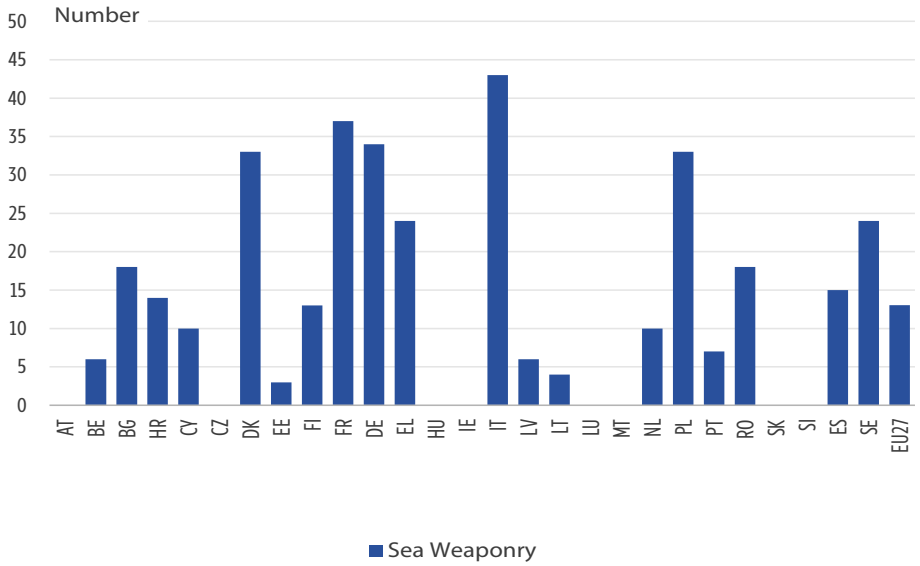
Figure 9 – Military equipment (air weaponry) in Member States



Source: Own estimation based on EDA, SIPRI and NATO data.

The third major segment of military equipment is represented by sea weaponry. As shown in Figure 10, the large states, especially France, own aircraft carriers (as do Italy and Spain). Frigates are owned in high numbers by France, Italy, Spain and Greece, and destroyers approximately by the same countries. On the other hand, mine vessels are more evenly distributed among the MS, with many more possessing this type of weaponry. Only a number of MS are actively involved in the renewal of the maritime park, the other states (especially the former communist ones) having outdated equipment that requires replacement.

Figure 10 – Military equipment (sea weaponry) in Member States



Source: Own estimation based on EDA, SIPRI and NATO data.

III. Defence procurement expenditure analysis by supplier and type of equipment

Procurement is the process by which an organization, whether it is a government agency or a company, obtains the supplies, equipment, or other resources needed to carry out its operations. The notion of public procurement carried out for the benefit of the armed forces of the Member States represents the obtaining of goods and services related to the military sector at the EU level (Britz, 2023). In order to stimulate competition and promote integration, in recent decades, public procurement practices in Member States have undergone major changes to ease the process. Instead, in the defence sector, an opposite phenomenon occurred unnoticed: in the attempt to protect the domestic military sectors, the public procurements of the Member States distorted the EU internal market and reduced openness (Smith et al., 2015).

In the last decade, at the level of the EU commission, there is a concern for improving and harmonizing the previous procedures that have proven ineffective in the field of defence (Czibik et al., 2021). The field of defence was considered a national field in which the national sovereignty of the member states prevailed, they being able to act to the detriment of the internal market by invoking Article 346 TFEU: '[...] is necessary for the protection of the essential interest of security [an SM]' , Member States can exclude certain regulations from competition laws. In 2009, Directive 2009/81/EC on the defence market was adopted, which assumed that European cooperation projects are subject to the same competition rules as national or third-country products. Acquisitions in the field of defence represent major differences compared to private ones. Military products must have the most modern technology, meet the highest standards, be sufficiently robust for survival in military operations and be able to be used for a long period of decades (Hoerber et al., 2021).

For their defence, MS need a set of military capabilities to fulfill the missions assigned to their armed forces. Traditionally, these capacities depend on the goods and products provided by their own defence industries, trying to preserve, as much as possible, their national autonomy (Heuninckx, 2017). Especially in top technical fields, MS have used public procurement in the field of defence as traditional policy instruments to promote the national technological and industrial base. In the field of defence, the standard national policy of member states is to finance a national R&D base, through the national budget and domestic companies, to maintain as much as possible a national supply chain. If there is no national base for the acquisition of military goods, MS usually choose projects under co-development with several member states (the Eurofighter or the A400M system). Although a number of states (e.g. US) rarely and only exceptionally acquire foreign military equipment, Member States also use significant quantities of foreign weapons in their military supplies, but only if there is no national equivalent. Instead, at the EU level, starting with the 60s, there were a series of multinational collaboration projects that included attack aircraft, transport aircraft, helicopters, warships, armored combat vehicles. Especially after the 90s, there was a wave of cooperation and industrial consolidation in the field of defence: in the field of helicopters (establishment of the Franco-German company Eurocopter in 1992 and the Anglo-Italian AgustaWestaland in 2000), aerospace (merger in 2000 of three large companies French, German and Spanish aerospace companies and the creation of European Aeronautic Defence and Space (EADS), missiles (merger in 2001 of three companies from Great Britain, France and Italy through the formation of MBDA) (Briani, 2013).

The sources of equipment purchases can be multiple, but there can be a description of them in terms of the development/production location or the organization that supplies them. Thus, a country can

acquire military equipment by: a) importing goods developed and produced in another country b) domestic production of goods developed in another country c) designing and producing in collaboration with other countries d) developing and domestic production. Economically, the least expensive is import, followed by domestic production under license, and the most expensive is development and own production. Usually, the big European countries turn to their own development and production (Italy, France, Germany, Spain, Sweden). Medium-sized states call for the local development of foreign weapons, but most of the time through license contracts, and small states directly import these products.

Next, we carried out an analysis of defence procurement for Member States for the period 2005-2022. The data are estimated taking into account the main public procurement contracts, separated by value and country of origin. The results of our analysis are presented in Figures 11 and 12.

For each country, we collected the data for defence procurement expenditure on types of equipment purchased and the supplier of the equipment. The value of the total procurement expenditure by supplier or by equipment is calculated based on the declared quantity and procurement value as indicated in the public procurement contracts by the acquirer. Where the procurement values are not available, an estimated value based on the average price of the equipment is used. The data sources were SIPRI, NATO and national Ministry of Defence databases and the values were provided in 2015 constant prices.

The suppliers are classified into five categories:

a. The host country	**b. Other EU countries**
c. The NATO countries (without EU and US)	d. US
e. The rest of the world	

The weaponry is classified into 10 categories:

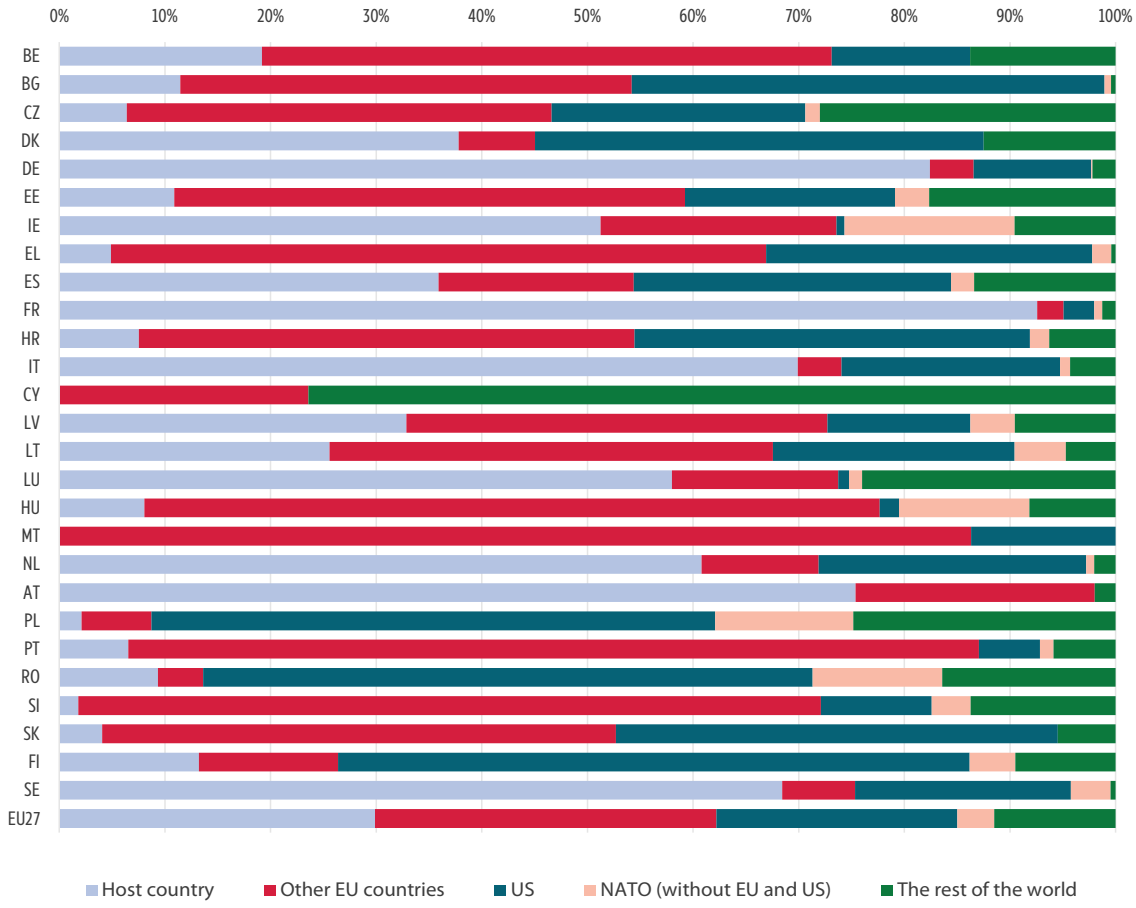
a. Airdefence systems	**f. Missiles**
b. Aircrafts	g. Naval weapons
c. Armoured vehicles	h. Satellites
d. Artillery+other	i. Radars
e. Engines	j. Ships

a. Defence procurement analysis by supplier

There are significant differences between Member States (Figure 11). Two MS (France and Germany) purchased military equipment mainly from the internal source, the percentage of purchase exceeding 75%. Moreover, these MS present the most important defence industry at the European level. Other MS also made military purchases from the national perimeter in significant proportions (Sweden, Netherlands, Italy, Austria). Medium and small states, which do not have locally developed defence industries, have proportions between 5-50%. Two MS (Malta and Cyprus) resorted only to imports for public acquisitions in the field of defence. The second largest supplier for MS is the US, most of them (25 out of 27) purchasing American military equipment. For a number of medium-sized states, the US is even the main supplier of armaments (Poland, Slovakia, Finland, Denmark, Bulgaria). The other NATO states represent another source of military acquisitions, especially for medium-sized states (Slovakia, Slovenia, Portugal, Malta, Latvia, Hungary, Estonia, Croatia,

Belgium), this becoming the main one. Military purchases from third countries are found in a low proportion in the field of defence, with the only exception of one state, Cyprus, where they are the majority.

Figure 11 – Percentage of defence procurement value by supplier for each EU27 member states

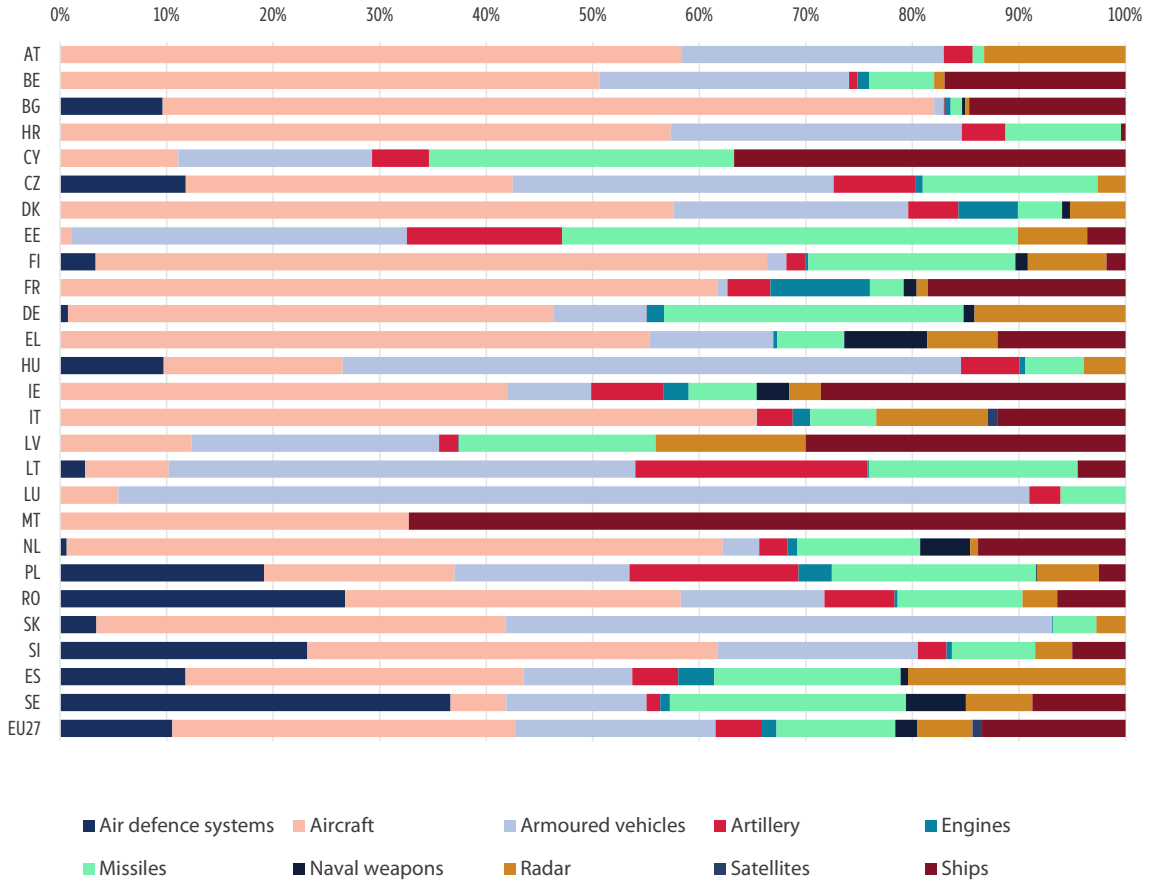


Source: Own elaboration based on EDA, NATO and SIPRI data.

b. Defence procurement analysis by type of equipment

Figure 12 shows the percentage of acquired weapon types by country, indicating a fragmented approach to defence procurement across Europe, with no single type of weapon system dominating uniformly across all countries, each country exhibiting a unique procurement profile, with varied investments in different weapon types. This diversity likely reflects each country's strategic defence priorities, geographical considerations, existing capabilities, and budgetary constraints. Commonalities can be observed in several countries investing significantly in certain types of equipment like air defence systems, engines, and ships, which are critical for national defence. Unique procurement trends are also visible, such as some countries focusing heavily on naval weapons or artillery, which might be driven by their specific defence strategy or geographic needs (e.g., countries with large coastlines emphasizing ships).

Figure 12 – Percentage of acquired weapon types for each EU27 member states



Source: Own elaboration based on EDA, NATO and SIPRI data.

Many countries show a substantial proportion of their defence budgets allocated to ships and air defence systems. Greece and Italy appear to allocate a significant portion of their procurement budget to ships. This is likely due to their geographical positioning with extensive coastlines and strategic interests in the Mediterranean Sea, necessitating robust naval capabilities for defence and security. Sweden also shows considerable investment in ships, which aligns with its historical and strategic focus on naval defence to protect its extensive archipelago and Baltic Sea interests. Germany and Netherlands seem to have a significant investment in air defence systems. This could be driven by the necessity to protect airspace in densely populated and industrially essential areas, and as part of their commitments to NATO's integrated air and missile defence. Poland also invests heavily in air defence systems, possibly influenced by its geographical position and recent geopolitical tensions in Eastern Europe, increasing the need for robust air defence capabilities.

Investments in categories like missiles, radar, and nuclear weapons vary significantly among countries. Strategic decisions here could be influenced by international alliances, internal technological capabilities, and the perceived level of threat. France shows a notable portion of its budget dedicated to missile systems. France's focus on missile technology could be attributed to its global military presence and the need for strategic long-range capabilities in both defence and

projection roles. United Kingdom (if included in the chart) typically has substantial investments in missile technology, aligning with its strategic deterrent and global power projection capabilities. Czech Republic and Austria might invest more in radar systems, which are important for airspace monitoring and integration into wider defence networks, possibly reflecting a strategic investment in surveillance and early warning systems. Regarding nuclear weapons, France would be a key example in Europe, maintaining its status as a nuclear power with a doctrine that includes nuclear deterrence as a cornerstone of national defence strategy.

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Building a European defence union is at the top of the EU's policy agenda. It is essential to preserving the security and wellbeing of EU society from current and future geopolitical threats. A reflection on the efficiency and quality of defence spending is a crucial first step in this process.

Based on research carried out for the European Parliamentary Research Service, this report investigates the potential gains from deeper European cooperation on defence spending that leverages the continent's economies of scale regarding: (i) military forces and strategic assets, (ii) defence equipment procurement, and (iii) research into emerging disruptive technologies.

The cost of non-Europe in defence spending is estimated to range from €18 to €57 billion per year. EU action to boost the efficiency and quality of European defence spending could also create jobs, improve the certainty of the business environment and boost the rule of law.

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