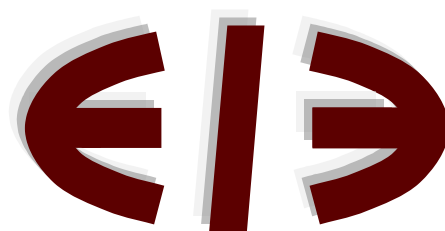


Cold War 2.0 and Defence Readiness

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Cold War 2.0 and Defence Readiness*

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Abstract

Europe is raising defence commitments under conditions of geoeconomic fragmentation, but fiscal commitments do not automatically become usable capability. This paper asks how non-kinetic geoeconomic shocks affect the capacity of European countries to convert defence resources into readiness-enabling capability. It develops a readiness-enabling index for European countries that combines four components: macroeconomic capacity, sectoral resilience, defence-industrial capability, and logistics and sustainment. The index is calculated at country level and reported through disclosure-controlled regional aggregates. It is a diagnostic measurement framework, not an estimate of classified operational readiness, combat effectiveness, military power, or causal battlefield outcomes. The results show that readiness-enabling capacity is uneven across Europe. Stronger aggregate profiles remain constrained by certified surge conversion, while countries on the eastern and south-eastern flank face more binding logistics, replenishment, air-defence, ammunition, infrastructure, and production-depth constraints. Across scenarios, losses are largest when geoeconomic fragmentation, supply-chain disruption, and reduced external support occur simultaneously. The paper contributes to defence economics by modelling readiness as an economic-industrial conversion problem under stress and by showing that binding constraints differ across countries, making uniform spending targets insufficient guides to preparedness.

Keywords: defence economics; defence readiness; geoeconomic fragmentation; defence-industrial base; military logistics; supply-chain resilience; NATO burden sharing; Europe.

JEL Codes: F51; F52; H56; L64; O25; R11.

*The authors are solely responsible for the content of the report. The views expressed are purely those of the authors and may not in any circumstances be regarded as stating an official position of NATO, EU institutions or Latvian National Armed Forces. Any remaining errors are ours.

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1 Introduction

Europe's security environment has entered a period of sustained strategic stress. Russia's full-scale invasion of Ukraine has increased the perceived probability of high-intensity conflict on the European continent, while tensions in the Indo-Pacific and the Middle East raise the possibility that scarce allied capabilities, production capacity, munitions, air defence, intelligence assets, sealift, and maintenance resources could be demanded simultaneously across multiple theatres (Kendall-Taylor et al., 2025; Lee, 2024; Cancian and Park, 2026; Málek and Abram, 2026). The economic environment has also changed. Trade, finance, technology transfer, raw-material access, energy, shipping, and industrial capacity are increasingly shaped by geopolitical alignment (Farrell and Newman, 2019; Aiyar et al., 2023; European Commission, 2024; NATO, 2024). Under these conditions, a non-kinetic geoeconomic shock can reduce readiness-enabling capacity even if no allies' territory is directly attacked.

This paper asks how geoeconomic shocks affect the capacity of European countries to convert defence resources into readiness-enabling capability. It argues that readiness under stress depends less on aggregate expenditure alone than on the weakest link in a conversion chain connecting fiscal resources, industrial inputs, certified production, stockpiles, maintenance, logistics, and procurement commitments. Defence spending is therefore an input rather than an outcome. It improves readiness only when it can be converted into certified production, qualified suppliers, available labour, resilient logistics, maintainable platforms, and sufficient stocks before crisis conditions materialise. A budget increase that arrives after suppliers have exited the market, inventories have been depleted, maintenance capacity is saturated, or critical inputs are unavailable may raise planned expenditure without raising near-term readiness-enabling capacity.

The gap in the existing debate is that Europe's readiness problem is often framed either as a spending problem or as a force-structure problem. Both perspectives are important and incomplete. Higher spending produces more usable output only when procurement cycles, supply chains, labour availability, certification requirements, and replenishment capacity allow expenditure to become delivered capability. Force structure does not translate into sustained capability when maintenance, spare parts, munitions, and transport are insufficient. The missing analytical link is the conversion mechanism between economic resources and usable readiness-enabling capacity under geoeconomic stress.

The paper's main finding is that Europe's readiness-enabling constraints are uneven across country-level calculations and the reporting aggregates used to present them. Analysed countries in the Central-Western Industrial Core have the strongest aggregate readiness-enabling capacity, while still facing constraints in converting broad industrial depth into certified surge output. Analysed countries in the Nordics and South-West Mediterranean have moderate-to-strong readiness-enabling capacity, with constraints concentrated in high-technology inputs, missile components, naval and air sustainment, energy-sensitive production, and logistics. Countries in the Baltic-Polish Eastern Flank and the Black Sea-Balkans region face more binding constraints in ammunition

demand, air-defence replenishment, logistics, infrastructure, and limited production depth. These differences imply that a common spending target or a single procurement initiative cannot address all readiness-enabling constraints.

The findings suggest that preparedness depends on the binding conversion constraint. Credible procurement demand, framework contracts, industrial surge clauses, supplier qualification, strategic stockpiling, standardisation, maintenance capacity, transport resilience, and replenishment plans matter alongside aggregate spending commitments. Countries whose binding constraint is logistics differ from countries whose binding constraint is critical inputs or supplier depth. Preparedness is therefore a question of both how much Europe spends and whether spending can be converted into production, inventories, maintenance, and logistics before the shock arrives.

The remainder of the paper proceeds as follows. Section 2 states the contribution and scope of inference. Section 3 reviews the related literature. Section 4 presents the analytical framework. Section 5 describes index construction and data. Section 6 presents the scenario logic. Section 7 reports reporting-aggregate results. Section 8 summarises robustness and sensitivity. Section 9 discusses implications for European defence planning, industrial policy, stockpiles, procurement, and NATO burden sharing. Section 10 concludes. Technical details, indicator transformations, concordances, equations, and long robustness tables are reported in the online appendix.

2 Contribution and scope of inference

This paper contributes a readiness-enabling index for Europe under geoeconomic stress. The index measures the economic-industrial conditions that make readiness feasible: macroeconomic capacity, sectoral resilience, defence-industrial capability, and logistics and sustainment. It measures the conditions that allow resources to become usable capability, not classified operational readiness, combat effectiveness, military power, or the causal effect of a shock on battlefield outcomes. Its purpose is to diagnose whether fiscal commitments, industrial inputs, procurement contracts, inventories, maintenance capacity, and logistics networks can be converted into usable capability under stress.

The paper makes three academic contributions. First, the conceptual contribution is to model readiness as an economic-industrial conversion problem under stress. A higher defence budget is necessary for rearmament and becomes sufficient only when critical inputs are available, suppliers are resilient, production lines can expand, stocks are adequate, maintenance capacity is available, and certification requirements do not delay output. The paper therefore shifts attention from expenditure commitments to the conversion mechanism that links public resources to usable, sustainable capability.

Second, the measurement contribution is a readiness-enabling index that captures constraints on conversion capacity. The macroeconomic component captures fiscal, price, output, labour, and energy conditions. The sectoral component captures exposure to concentrated and non-substitutable inputs. The defence-industrial component captures supplier depth, surge capacity, lead times, certification, and defence-critical production bottlenecks. The logistics and sustainment component captures stocks, maintenance,

transport, pre-positioning, spare parts, and replenishment speed. These components are combined into scenario-specific indices and decomposed to identify the binding constraint.

Third, the empirical and policy contribution is to show that European countries face different binding constraints, so uniform spending targets are insufficient. Public reporting uses disclosure-controlled regional aggregates because many indicators are proxy-based, commercially sensitive, or operationally sensitive; the underlying calculations remain at country level and avoid country rankings. Countries constrained by inventories and replenishment require a different sequence of measures from countries constrained by critical inputs, surge capacity, or macro-fiscal headroom.

The unit of calculation is the country. Reporting aggregates are used only to present disclosure-controlled results and to identify broad patterns of constraint. The aggregation procedure is therefore a reporting and confidentiality device, not a claim that regions are unified actors or homogeneous defence economies.

What this paper does and does not do. This paper develops a disclosure-controlled framework for measuring economic-industrial constraints on readiness-enabling capacity. It compares reporting-aggregate constraint profiles, decomposes them into components, and evaluates a limited set of comparative statics. The index is a diagnostic instrument for identifying binding constraints, not an estimate of classified operational readiness, a prediction of war outcomes, a ranking of countries by military power, a disclosure of country-specific stocks, stockpile gaps, production capacities, or operational plans, or a measure of combat effectiveness.

3 Literature review

The paper connects three strands of literature that are usually analysed separately: defence economics; defence-industrial mobilisation; and geoeconomic and supply-chain vulnerability. Each strand contributes an important mechanism, but none alone provides a complete measurement framework for readiness-enabling capacity under strategic stress.

3.1 Geoeconomic and supply-chain vulnerability

The first strand studies trade networks, global value chains, and geoeconomic fragmentation. Classic work on vertical specialisation and trade in intermediate goods shows that production is distributed across borders and that the value of final output depends on complex chains of intermediate inputs (Hummels et al., 2001). Quantitative trade models emphasise the role of technology, geography, trade costs, and input linkages in shaping production patterns and welfare effects (Eaton and Kortum, 2002; Arkolakis et al., 2012). Work on global value chains explains how firms organise production across borders when stages differ in contract intensity, technology, and input specificity (Antràs and Chor, 2013). More recent work on geoeconomic fragmentation and weaponised interdependence shows that the same networks that generate efficiency can create

coercive leverage when states restrict access to trade, finance, technology, transport nodes, raw materials, or digital infrastructure (Farrell and Newman, 2019; Aiyar et al., 2023).

This literature contributes three insights to the present paper. First, interdependence is both a channel of efficiency and a channel of vulnerability. Second, the geography and concentration of network nodes matter because a small number of specialised suppliers can have system-wide effects. Third, geoeconomic shocks can be non-kinetic but still readiness-relevant. Export controls, sanctions, shipping disruptions, financial restrictions, technology denial, cyber-enabled commercial disruption, and raw-material restrictions can affect the availability, price, or timing of defence-relevant inputs.

The limitation of this literature for the present question is that it usually measures welfare, trade flows, production patterns, or exposure to fragmentation rather than readiness-enabling capacity. It helps identify why trade dependencies matter; it does not by itself specify when a trade or technology shock becomes a binding constraint on defence production, stockpile replenishment, maintenance, or logistics. A defence-relevant input may represent a small share of aggregate trade but a large share of a critical weapons-system bottleneck. Conversely, a large trade exposure may have little near-term readiness effect if substitution is easy or inventories are sufficient. The paper therefore uses the trade-network literature as the first layer of the framework, but extends it toward defence-industrial conversion and sustainment. The geoeconomic and supply-chain literature explains vulnerability to fragmentation and coercion, but it is not usually connected to defence readiness measurement.

3.1.1 Supply-chain propagation and input-output exposure

The second strand studies supply-chain propagation, production networks, and input-output exposure. Network models show that idiosyncratic shocks can generate aggregate fluctuations when production networks are sufficiently asymmetric or when key sectors occupy central positions (Acemoglu et al., 2012). Empirical work on natural disasters and global production networks shows that upstream shocks can propagate through firms and sectors when inputs are difficult to replace quickly (Boehm et al., 2019). Research on pandemic-era supply-chain disruption similarly shows that global input-output linkages can transmit shocks across borders even when final demand is unchanged (Bonadio et al., 2021). Recent work on networks, barriers, and trade emphasises that input-output structures can magnify the economic consequences of barriers and disruptions (Baqae and Farhi, 2024). Reviews of supply-chain risk highlight uncertainty, concentration, and the limits of just-in-time production under systemic stress (Baldwin and Freeman, 2022; Kancs, 2024).

This literature contributes the propagation logic used in the paper. Readiness-enabling capacity can be weakened by direct exposure, indirect exposure, and systemic exposure. Direct exposure arises when a defence-relevant product uses an input from a disrupted supplier. Indirect exposure arises when a disrupted input affects an upstream sector that supplies a defence-relevant producer. Systemic exposure arises when many sectors depend on a common constrained input, such as specialised electronics, energy-intensive materials, rare earth elements, explosives precursors, or precision components. The

input-output perspective is especially relevant for defence because defence production often combines specialised components, dual-use technologies, long qualification periods, and low-volume production lines.

The supply-chain literature identifies propagation mechanisms, not military-relevant bottlenecks by itself. Input-output tables are often too aggregated to distinguish between ordinary civilian input dependence and certified defence input dependence. A sector may appear resilient in aggregate data but contain a narrow defence-critical component that is difficult to substitute. Conversely, a sector may appear exposed in aggregate data but have limited relevance to near-term readiness. The paper therefore combines input-output exposure with defence-industrial mappings, lead-time assumptions, supplier concentration, and sustainment indicators. The aim is to measure propagation and identify whether propagation reaches a readiness-relevant constraint.

3.2 Defence economics

The third strand is defence economics and procurement. Defence economics emphasises that the defence sector differs from ordinary markets in several respects: demand is dominated by the state, output is often non-tradable or strategically controlled, prices may reflect low-volume specialised production, and procurement is shaped by uncertainty, security restrictions, industrial policy, and alliance commitments (Sandler and Hartley, 1995; Dunne, 1995; Hartley, 2007). The literature on the defence-industrial base highlights scale economies, monopsony demand, long development and procurement cycles, industrial-base fragility, and the risk that peacetime demand is insufficient to maintain mobilisation capacity. Work on defence output and procurement emphasises that budget authority and delivered capability are different objects (Hartley, 2012; IISS, 2022). Recent policy-oriented research on defence supply chains and industrial resilience stresses the importance of procurement dynamics, inter-organisational dependence, framework contracts, and credible long-term demand (Hellberg, 2026; NATO, 2024, 2025; European Commission, 2024).

This literature contributes the conversion mechanism at the core of the paper. A defence budget becomes readiness-enabling capacity only when it passes through procurement, contracting, certification, supplier qualification, skilled labour, production capacity, testing, maintenance, and delivery. Defence-industrial firms invest in surge capacity when expected demand is credible and when governments share the risks of maintaining idle or underutilised capacity. A large increase in orders may fail to raise near-term output if bottlenecks occur in energetic materials, machine tools, specialised labour, testing facilities, electronics, propulsion, shipyard capacity, airframe maintenance, or export-control approvals.

The limitation is that defence-economics research often focuses on procurement efficiency, industrial policy, cost escalation, or public finance rather than on the joint measurement of macroeconomic, sectoral, industrial, and logistics constraints under geoeconomic stress. It explains why spending is not automatically converted into capability; it does not provide a comparative reporting framework linking procurement constraints to supply-chain disruption, external-support diversion, stockpile depletion, and replenishment. The defence economics literature explains spending, burden

sharing, procurement, and alliance incentives, but often treats conversion frictions as secondary. This paper extends the defence-economics perspective by embedding procurement and industrial-base constraints inside a broader geoeconomic scenario framework.

3.3 Defence-industrial mobilisation, stockpiles, and sustainment

The fourth strand concerns readiness, stockpiles, sustainment, and defence-industrial mobilisation. Military readiness reporting systems distinguish between personnel, equipment, training, supply, maintenance, and mission capability (DoD, 2013, 2024; USMC, 2020). Policy work on European defence readiness and preparedness emphasises stockpiles, ammunition production, industrial capacity, mobilisation planning, and the availability of air defence, long-range fires, drones, maintenance, and replacement equipment (Kancs, 2025, 2026; Green, 2026; Cancian and Park, 2026). Work on critical materials and strategic reserves shows that some constraints cannot be resolved quickly because they depend on by-product metals, specialised processing capacity, environmental permitting, or concentrated upstream production (Nassar et al., 2015; Graedel et al., 2015; OECD, 2023; European Commission, 2023).

This literature contributes the sustainment logic of the paper. Readiness under stress depends on whether a force exists at the start of a crisis and whether it can be maintained, supplied, repaired, and replenished over time. Stockpiles reduce immediate vulnerability, but they require financing, rotation, standardisation, storage, security, and replacement. Replenishment depends on lead times, framework contracts, supplier depth, spare parts, maintenance workforce, transport corridors, and allied availability. Mobilisation capacity depends on whether peacetime planning has already identified critical suppliers, certified substitutes, production bottlenecks, and escalation triggers.

The limitation is that readiness and mobilisation discussions often contain sensitive information and are therefore difficult to compare across countries. Public indicators are incomplete, uneven, and sometimes proxy-based. Moreover, operational readiness metrics cannot be directly combined with macroeconomic and supply-chain indicators without careful interpretation. This paper addresses this problem by focusing on readiness-enabling capacity rather than classified operational readiness. It reports regional aggregates, identifies binding economic-industrial constraints, and treats the index as a diagnostic measurement exercise rather than as a military ranking. The defence-industrial mobilisation literature explains production depth, surge capacity, and procurement lead times, but often lacks a comparative measurement framework.

Existing work explains geoeconomic fragmentation, supply-chain propagation, defence procurement, and mobilisation constraints, but it rarely links these channels into a single measurement framework for readiness-enabling capacity. This paper integrates these literatures through the concept of readiness-enabling conversion capacity and treats readiness as an economic-industrial conversion problem under strategic stress.

4 Analytical framework

The model presentation in the main text is deliberately compact. It explains the mechanism, the index, the interpretation, the assumptions, and the scope of inference. Detailed notation, macroeconomic trade equations, sectoral exposure equations, defence-industrial equations, inventory equations, policy-simulation details, and concordance material are reported in the technical annexes.

4.1 Mechanism

The purpose of the model is to analyse impacts on defence readiness triggered by a non-kinetic geoeconomic shock. The shock may take the form of trade fragmentation, input restrictions, financial stress, shipping disruption, energy-price pressure, cyber-enabled commercial disruption, technology denial, or the diversion of external support to another theatre. The first effect is macroeconomic and sectoral: prices rise, fiscal space changes, demand is reallocated, imports become less reliable, and production networks face input constraints. The second effect is defence-industrial: suppliers face longer lead times, higher prices, missing inputs, labour shortages, or certification delays. The third effect is logistical and sustainment-related: inventories are depleted, maintenance backlogs rise, spare parts become scarce, and replenishment becomes slower. The final outcome is a readiness-enabling constraint. Figure 1 summarises this transmission mechanism and defines the object that the index measures.

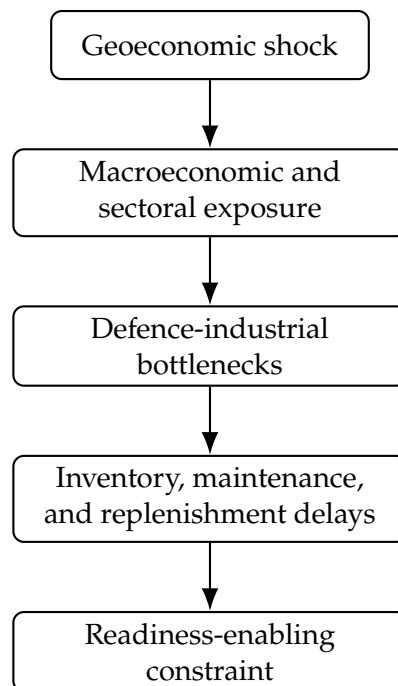


Figure 1: Conceptual transmission mechanism

The mechanism is intentionally sequential but not mechanical. Feedbacks are explicitly accounted for. A logistics constraint can raise demand for emergency procurement, which can raise prices and tighten macro-fiscal constraints. A critical-input shock can delay production, which can increase stockpile drawdown and worsen sustainment.

External-support diversion can increase domestic demand for systems that are already constrained by suppliers or inventories. The index is designed to capture these interacting constraints in a structured and transparent way.

This sequence provides a bridge between macroeconomic analysis and defence planning. A conventional macroeconomic shock may be small in aggregate but large for readiness-enabling capacity if it affects a constrained component. For example, a narrow disruption to energetic materials, propellants, microelectronics, optical sensors, or maintenance spares may have a limited effect on GDP but a substantial effect on air-defence production, artillery ammunition, drones, missiles, or platform availability. Conversely, a large aggregate trade shock may have a modest readiness effect if it falls on sectors with limited defence relevance or if substitutes and inventories are available. The framework therefore separates aggregate economic exposure from readiness-relevant exposure.

The conversion problem has three layers. The first is the resource layer: governments need fiscal capacity, labour, energy, and macroeconomic stability to expand defence demand without generating destabilising price or capacity pressures. The second is the production layer: firms need qualified suppliers, certified components, skilled labour, test facilities, and credible demand before they expand output. The third is the sustainment layer: military users need inventories, spare parts, maintenance capacity, transport, pre-positioning, and replenishment contracts to keep systems available after initial use. A weakness at any layer can limit readiness-enabling capacity even when the other layers are relatively strong.

The framework also distinguishes between stock constraints and flow constraints. Stock constraints arise from inventories, stored munitions, spare parts, repair capacity, and pre-positioned equipment. Flow constraints arise from the speed of production, replacement, maintenance, transportation, and contracting. Countries with adequate initial stocks but weak replenishment may appear resilient in the first phase of a crisis and constrained later. Countries with limited stocks but strong replenishment capacity may face immediate vulnerability but recover faster. This distinction is important for interpreting the comparative statics because stockpile measures and production-capacity measures operate on different timelines.

4.2 Index

The readiness-enabling index combines four components: macroeconomic capacity, sectoral resilience, defence-industrial capability, and logistics and sustainment. For country c and scenario s , the central index is

$$R_{c,s} = w_M M_{c,s} + w_S S_{c,s} + w_D D_{c,s} + w_L L_{c,s}, \quad (1)$$

where M , S , D , and L are scaled between zero and one, and the weights w_M , w_S , w_D , w_L sum to one. Higher values indicate stronger readiness-enabling capacity. Lower component values identify the constraint most likely to bind under the scenario. The aggregate index is therefore useful, but the component decomposition is the main empirical object for policy.

4.3 Interpretation

The index is diagnostic. It identifies relative economic-industrial constraints under maintained scenario assumptions, not the causal effect of a shock on operational readiness. A high value indicates that analysed countries in the reporting aggregate have stronger macroeconomic, sectoral, industrial, logistics, and sustainment conditions for converting resources into usable capability. A low value indicates that one or more components may bind under stress. The index should not be read as a country ranking, a combat-power ranking, or an operational readiness index.

4.4 Assumptions

The framework relies on five assumptions. First, readiness-enabling capacity depends on multiple components that are imperfect substitutes. High fiscal capacity eases but does not remove the constraint created by absent munitions production; strong industrial depth eases but does not remove the constraint created by depleted stockpiles; and large inventories ease but do not remove the constraint created by long replenishment lead times. Second, the relevance of each component depends on the scenario. Attrition-intensive scenarios place more weight on logistics and replenishment, while fragmentation scenarios place more weight on sectoral resilience and critical inputs. Third, public data are incomplete, so some variables require proxies and confidence flags. Fourth, disclosure control requires reporting aggregation. Fifth, the purpose of the framework is comparative diagnosis, not prediction.

4.5 What can and cannot be inferred

The framework can identify relative readiness-enabling constraints, compare component profiles, show how scenario assumptions change the ranking, and evaluate which policy levers are most likely to relax the binding component. It supports comparative diagnosis, not inference about classified stockpile levels, operational readiness, conflict outcomes, or whether countries in a reporting aggregate would prevail in a crisis. The paper therefore uses the language of readiness-enabling capacity and binding constraints throughout.

4.6 Propositions

The framework implies three propositions that guide the empirical interpretation. *Conversion proposition*: defence spending raises readiness-enabling capacity only when it relaxes the binding constraint in the conversion chain. *Bottleneck proposition*: the lowest-performing component matters more for near-term readiness-enabling capacity than the average level of resources. *Stress-amplification proposition*: geoeconomic shocks reduce readiness-enabling capacity most when they simultaneously affect critical inputs, logistics, replenishment, and external support.

5 Index construction and data

5.1 Index construction overview

The readiness-enabling index measures the relative strength of the economic, industrial, logistics, and sustainment conditions that allow resources to be converted into usable capability under stress. It is a measurement framework, not an estimated causal model. The index does not identify treatment effects, predict conflict outcomes, or estimate operational readiness. It organises observable and proxy indicators into a transparent diagnostic structure. It is calculated as

$$R_{r,s} = w_M M_{r,s} + w_S S_{r,s} + w_D D_{r,s} + w_L L_{r,s}. \quad (2)$$

The index has four components. *M* measures macroeconomic capacity: fiscal headroom, defence-inflation exposure, energy-price sensitivity, labour availability, and the ability to finance additional defence demand without destabilising the broader economy. *S* measures sectoral resilience: the extent to which defence-relevant sectors depend on concentrated suppliers, disrupted inputs, non-substitutable components, or vulnerable upstream production networks. *D* measures defence-industrial capability: supplier depth, surge capacity, production lead times, certification bottlenecks, specialised labour, and the ability to convert peacetime industrial capacity into defence output. *L* measures logistics and sustainment: inventories, stockpiles, spare parts, maintenance, transport, pre-positioning, replenishment speed, and the ability to sustain capability after initial drawdown.

Table 1: Index components, mechanisms, and readiness-enabling interpretation

Component	Mechanism	Readiness-enabling interpretation
Macroeconomic capacity	Fiscal and price-space constraints	Ability to finance and absorb defence expansion.
Sectoral resilience	Exposure to energy, inputs, and supply chains	Ability to maintain production under disruption.
Defence-industrial capability	Production depth, supplier base, and surge capacity	Ability to convert demand into certified output.
Logistics and sustainment	Transport, maintenance, stocks, and replenishment	Ability to sustain and replace usable capability.

Indicators are normalised so that higher values mean stronger readiness-enabling capacity. For indicators where high raw values indicate vulnerability, such as supplier concentration or import dependence, the scale is reversed. Each indicator is transformed to a zero-to-one range using a documented normalisation procedure. Component scores are computed as weighted averages of normalised indicators. If an indicator is not applicable, the denominator is adjusted. If an indicator is missing, commercially sensitive, classified, or available only through a proxy, the observation is assigned a confidence flag and evaluated under low, central, and high assumptions.

Weights are scenario-specific. The balanced baseline uses equal component weights. Attrition-intensive scenarios place more weight on logistics and sustainment and defence-industrial capability. Supply-chain-fragmentation scenarios place more weight on sectoral resilience and defence-industrial capability. External-support-reduction scenarios increase the weight on logistics, sustainment, and domestic industrial capability. The combined multi-theatre stress scenario increases the weight on all components most directly affected by simultaneous fragmentation, attrition, and external-support diversion.

Robustness checks are performed in five ways. First, equal weights are compared with alternative scenario-specific weights to test whether rankings depend on the baseline weighting scheme. Second, judgement-based defence-industrial indicators are excluded or down-weighted to test whether findings depend on less observable variables. Third, missing-data assumptions are varied using low, central, and high imputations. Fourth, scenario calibration is varied by changing stress multipliers, allied-availability assumptions, and surge-capacity assumptions. Fifth, aggregation from country to region is tested by comparing population-weighted, GDP-weighted, defence-expenditure-weighted, and unweighted reporting aggregation. Results are considered robust when the identity of the binding component and the broad reporting-aggregate ranking remain stable across these tests.

The interpretation is straightforward. A high aggregate score indicates stronger readiness-enabling capacity under the specified scenario. A low aggregate score indicates that one or more economic-industrial constraints are likely to bind. The component with the lowest value is interpreted as the binding constraint, subject to scenario-specific validation. The index is diagnostic, not causal. It ranks readiness-enabling constraints, not military effectiveness.

Early limitations. Several limitations are important for interpretation. Results are sensitive to proxy quality. Some defence-industrial variables are partly judgement-based because supplier depth, surge capacity, and lead times are not fully observable in public data. Classified data constraints require disclosure-controlled aggregation. Regional results should not be read as country rankings. The index is diagnostic, not causal. These limitations define its correct use as a transparent tool for comparing constraints and prioritising further validation.

5.2 Index validity and interpretation

The index is intended to measure readiness-enabling conversion capacity. Its construct validity rests on the claim that usable capability under stress requires four linked conditions: macroeconomic capacity to finance and absorb expansion, sectoral resilience to keep inputs available, defence-industrial capability to transform demand into certified output, and logistics and sustainment to keep systems supplied, repaired, transported, and replenished. Its content validity follows from the indicator set, which covers macro-fiscal constraints, energy and input exposure, supplier depth, surge capacity, certification, inventories, maintenance, transport, and replenishment. Its face validity is assessed by comparing the component profiles with known defence-industrial patterns:

broad industrial depth in the core, high-technology and northern logistics constraints in the Nordics, maritime sustainment constraints in the South-West Mediterranean, and attrition and replenishment constraints on the eastern and south-eastern flank. The limits of validity are equally important. The index measures economic-industrial conditions that enable readiness; it does not measure operational readiness, military power, combat effectiveness, or realised battlefield outcomes.

5.3 Aggregation and interpretation

The index is built from country-level indicators and reported through regional aggregates. Within each component, indicators are grouped by concept. For *M*, the main concepts are fiscal capacity, output exposure, price exposure, energy sensitivity, and labour availability. For *S*, the main concepts are input concentration, supplier substitutability, upstream exposure, and critical-material dependence. For *D*, the main concepts are supplier depth, production lead times, surge capacity, certification, and defence-critical component availability. For *L*, the main concepts are inventories, maintenance, spare parts, transport, pre-positioning, and replenishment speed.

The aggregate index is useful for comparison. The component decomposition is the most policy-relevant output, not the aggregate index alone. Two reporting aggregates can have similar aggregate scores but different binding constraints. Countries with strong macroeconomic capacity and weak logistics require a different policy package from countries with weak sectoral resilience and moderate logistics. The paper therefore reports both headline rankings and component decompositions.

A second design choice is to separate measurement from interpretation. The index uses public and proxy indicators to generate comparable scores, but the scores are interpreted through the component structure. This prevents the aggregate index from hiding the source of vulnerability. A region can improve the aggregate score by raising any component, but the largest readiness gain usually comes from relaxing the lowest component. The empirical section therefore reports the headline ranking only as the starting point. The component decomposition, scenario comparison, sensitivity table, and ranking-change figure carry the substantive interpretation.

5.4 Identification and interpretation

The empirical strategy is a structured measurement exercise. The index identifies relative constraints under scenario assumptions, not a causal parameter in the econometric sense or the effect of a specific shock on realised operational readiness. The appropriate interpretation is therefore diagnostic and comparative. If the *L* component for a reporting aggregate falls sharply under an attrition-intensive scenario, the result means that logistics, inventories, maintenance, or replenishment are likely to bind before other components under that scenario. It indicates a binding readiness-enabling constraint, not military failure or a specific operational outcome.

This interpretation is especially important because readiness-relevant data are partly classified and because public proxies differ in quality. The paper uses reporting aggregation and sensitivity analysis to reduce the risk of overinterpretation. Findings

Table 2: Scenario weights used in the readiness-enabling index

Scenario	w_M	w_S	w_D	w_L	Rationale
Balanced baseline	0.25	0.25	0.25	0.25	Equal weights benchmark for cross-region comparison.
Attrition-intensive	0.15	0.20	0.30	0.35	Higher importance of replenishment, maintenance, ammunition, and surge output.
Prolonged rivalry	0.25	0.25	0.25	0.25	Managed de-risking allows adaptation across all components.
Supply-chain fragmentation	0.15	0.35	0.35	0.15	Critical inputs, substitutability, and supplier depth receive greater weight.
External-support reduction	0.15	0.20	0.30	0.35	Domestic production, inventories, and sustainment matter more when allied support is less available.
Combined stress	0.20	0.25	0.30	0.25	Multiple constraints bind simultaneously; defence-industrial capability receives the largest weight.

Notes: Weights sum to one within each scenario and are used for public reporting and sensitivity analysis. w_M , w_S , w_D , and w_L denote the scenario weights on macroeconomic capacity, sectoral resilience, defence-industrial capability, and logistics and sustainment, respectively. Alternative specifications are summarised in Table 7.

are strongest when three conditions hold: the component ranking is stable across weights, the data-confidence flag is high or medium, and the same binding constraint appears across multiple scenarios. Findings are weaker when they depend on a single proxy, a low-confidence indicator, or a narrow weighting assumption.

5.5 Data

Table 3 summarises the data structure. The table is intentionally compact. Detailed data definitions, concordances, and implementation procedures are reported in the technical annexes.

Table 3: Data inputs for the readiness-enabling index

Component	Concept measured	Example indicators	Main data sources	Direction
<i>M</i>	Macro-economic capacity	Fiscal space, GDP exposure, inflation sensitivity, labour availability, energy-price exposure	Macro accounts, public finance data, trade data, labour indicators	Higher = stronger
<i>S</i>	Sectoral resilience	Sectoral concentration, import dependence, input substitutability, exposure to restricted suppliers, critical-material dependence	Input-output tables, trade statistics, sector classifications, critical-material lists	Higher = stronger
<i>D</i>	Defence-industrial capability	Supplier depth, surge capacity, production lead times, certification bottlenecks, defence-critical components	Defence-industrial mapping, procurement data, industry reports, capability taxonomies	Higher = stronger
<i>L</i>	Logistics and sustainment	Stockpiles, maintenance capacity, spare parts, transport resilience, pre-positioning, replenishment speed	Logistics proxies, readiness reports, infrastructure, sustainment, inventory indicators	Higher = stronger

Notes: The table summarises the public data architecture for the readiness-enabling index. *M* denotes macroeconomic capacity, *S* sectoral resilience, *D* defence-industrial capability, and *L* logistics and sustainment. Some variables are proxy-based or judgement-based because country-level defence-industrial, stockpile, and sustainment data are commercially or operationally sensitive.

The unit of analysis is the country, but results are reported by region. Country-level measurement preserves analytical granularity, while reporting aggregation reduces disclosure risk and avoids the appearance of a public country ranking. The five reporting aggregates are the Nordics, Baltic-Polish Eastern Flank, Central-Western Industrial Core, South-West Mediterranean, and Black Sea–Balkans. In tables, abbreviated labels are used for space; in the main text, the full regional names are used.

Reporting aggregation is used for four reasons. First, it reduces sensitivity around country-specific vulnerabilities in stockpiles, industrial bottlenecks, logistics nodes, and replenishment capacity. Second, it avoids implying precise national rankings

from public and proxy-based information. Third, it reflects the cross-border character of European defence-industrial production, maintenance, logistics, and procurement networks. Fourth, it is appropriate for identifying common binding constraints that require regional or alliance-level coordination rather than purely national interpretation.

The measurement strategy also has a practical purpose. A readiness-enabling index is useful only if it can be updated as information improves. The framework is therefore designed so that more precise classified or proprietary information can replace public proxies without changing the conceptual structure. If a better measure of supplier depth becomes available, it updates D . If a better measure of stockpile rotation or maintenance backlog becomes available, it updates L . If a more detailed input-output concordance becomes available, it updates S . This modularity allows the public results to remain transparent while leaving room for more detailed internal validation.

The index also separates exposure from resilience. A region may be exposed to a disrupted input but resilient if it has inventories, substitutes, diversified suppliers, or domestic production capacity. Another region may have lower measured exposure but weaker resilience if a small number of inputs are non-substitutable and inventories are thin. For this reason, the component indicators combine dependence measures with substitutability, supplier depth, and lead-time measures. This prevents the index from treating all trade exposure as equally harmful or all domestic production as equally protective.

Finally, the regional reporting design is part of the methodology. Country-level measurement is necessary because macroeconomic, sectoral, industrial, and logistics conditions differ across countries. Public country rankings, however, would create false precision and could reveal sensitive information. Regional aggregates reduce those risks while preserving enough variation to identify the main constraint patterns. The paper therefore reports reporting-aggregate results and treats country-level values as the internal basis for aggregation rather than as public findings.

6 Scenarios

Scenario analysis is used because the relationship between geoeconomic shocks and readiness-enabling capacity depends on the type of stress. A shock that primarily affects high-technology inputs has different implications from one that primarily affects ammunition attrition, energy prices, shipping, or allied availability. The scenarios are structured stress tests designed to reveal which components of readiness-enabling capacity are most likely to bind under plausible strategic conditions, not forecasts.

6.1 Scenario logic

The paper uses five scenarios. The balanced baseline captures a strategic-stress environment in which Europe faces elevated defence demand, persistent geopolitical uncertainty, and moderate supply-chain disruption. The attrition-intensive scenario places greater stress on ammunition, air defence, maintenance, and replacement equipment. The prolonged-rivalry scenario assumes sustained strategic competition with managed

de-risking and gradual investment in resilience. The supply-chain-fragmentation scenario emphasises input restrictions, supplier concentration, technology denial, and trade fragmentation. The external-support-reduction scenario captures the possibility that allied capabilities and production capacity are diverted to another theatre. The combined multi-theatre stress scenario, used in the ranking-change figure, combines fragmentation, attrition, price stress, and external-support diversion.

The scenario design follows four principles. First, scenarios must be non-kinetic: the direct shock is geoeconomic rather than a kinetic attack on European territory, citizens or infrastructure. Second, scenarios must be readiness-relevant: they must affect production, inventories, sustainment, logistics, or external support. Third, scenarios must be comparable: each scenario changes weights and stress assumptions in a transparent way. Fourth, scenarios must be disclosure-controlled: the public results are reporting aggregates and do not reveal country-specific sensitive information.

The balanced baseline should be interpreted as the central comparison case. It assumes that European states continue to expand defence demand, that Ukraine-related support continues to absorb ammunition and air-defence capacity, and that trade and input markets remain under persistent but not extreme stress. The attrition-intensive scenario increases the importance of munitions, air defence, maintenance, replacement equipment, and spare parts. It is designed to capture a high-consumption environment in which the speed of replenishment matters more than the initial size of the force. The prolonged-rivalry scenario assumes that strategic stress persists but that governments and firms have time to adapt through managed de-risking, framework contracts, and gradual capacity expansion. The scenario weights reported in Table 2 translate these qualitative assumptions into the index aggregation.

The supply-chain-fragmentation scenario is the most direct application of the geoeconomic-fragmentation literature. It increases the penalty for concentrated suppliers, non-substitutable inputs, critical-material dependence, technology denial, and long certification periods. The external-support-reduction scenario is motivated by the possibility that U.S. or allied attention, production, munitions, air defence, ISR, sealift, or maintenance capacity may be diverted to another theatre, a concern also highlighted by recent dual-contingency crisis simulation work (Málek and Abram, 2026). The combined multi-theatre stress scenario is a severe but analytically useful stress test that asks what happens when the most readiness-relevant channels bind at the same time, not a forecast of a specific crisis.

The scenarios are implemented through changes in weights, stress multipliers, and component-specific assumptions. Attrition-intensive conditions increase the relevance of L and D because sustainment and replenishment become central. Supply-chain fragmentation increases the relevance of S and D because the availability of critical inputs and qualified suppliers becomes more important. External-support reduction increases the relevance of domestic D and L because regions can rely less on allied inventories and production capacity. The prolonged-rivalry scenario allows some adaptation, so it places less penalty on constraints that can be relaxed through gradual de-risking.

7 Results

The results section reports what the index shows; Section 9 interprets what those results imply for planning, industrial policy, procurement, and NATO burden sharing. Five headline findings structure the evidence. First, readiness-enabling capacity is uneven across European countries. Second, the strongest aggregate profiles are still constrained by certified surge conversion. Third, countries on the eastern and south-eastern flank face more binding logistics, replenishment, and production-depth constraints. Fourth, combined geoeconomic fragmentation and reduced external support produce the largest losses. Fifth, binding components are more robust than precise aggregate scores. The results are reported as disclosure-controlled regional aggregates of country-level calculations. They rank readiness-enabling constraints, not military effectiveness.

7.1 Headline index ranking

Table 4 reports the headline ranking under the balanced baseline. Analysed countries in the Central-Western Industrial Core have the strongest aggregate readiness-enabling profile. The Nordics and South-West Mediterranean occupy intermediate positions as reporting aggregates. Countries in the Baltic-Polish Eastern Flank and the Black Sea–Balkans region are more constrained. The distance between reporting aggregates is more informative than the rank itself. The top reporting aggregate combines broad macroeconomic and industrial depth, while the lowest-ranked reporting aggregate is constrained by production depth, logistics, and replenishment capacity.

Table 4: Headline reporting-aggregate ranking of the readiness-enabling index

Rank	Region	Index	Interpretation
1	Industrial Core	0.72	Strongest aggregate profile; main constraint is surge conversion rather than aggregate industrial depth.
2	Nordics	0.64	Moderate-to-strong profile; vulnerable to high-technology inputs, air and naval sustainment, and northern logistics.
3	South-West Med.	0.62	Moderate profile; vulnerabilities are concentrated in maritime sustainment, missile components, energy exposure, and Mediterranean logistics.
4	Baltic-Polish Flank	0.52	Medium-low profile; constrained by ammunition demand, air-defence replenishment, forward logistics, and rapid replacement capacity.
5	Black Sea–Balkans	0.46	Lowest aggregate profile; constrained by limited production depth, transport infrastructure, logistics, and air-defence replenishment.

Notes: Scores range from zero to one, with higher values indicating stronger readiness-enabling capacity. The table uses abbreviated reporting-aggregate labels for space: South-West Med. denotes South-West Mediterranean, and Black Sea–Balkans denotes countries in the Black Sea–Balkans region. The estimates refer to readiness-enabling constraints, not military effectiveness or combat readiness.

The ranking should be interpreted as a ranking of constraints, not military effectiveness.

The Central-Western Industrial Core performs best because it combines fiscal capacity, industrial depth, and dense supplier networks. Yet its weakest component is logistics and sustainment, reflecting the challenge of converting broad industrial strength into timely certified output, inventories, and replenishment. The Nordics benefit from strong institutions, high technology, and fiscal capacity, but are exposed to specialised inputs, air and naval sustainment, and northern logistics. The South-West Mediterranean has important maritime and aerospace capacity, but faces energy exposure, naval sustainment constraints, missile-component dependence, and Mediterranean logistics challenges. The Baltic-Polish Eastern Flank has high strategic demand and proximity to likely attrition scenarios, but is constrained by replenishment, air defence, infrastructure, and rapid replacement capacity. Countries in the Black Sea–Balkans region have the lowest aggregate profile because limited production depth and transport constraints interact with air-defence and logistics vulnerabilities.

7.2 Component decomposition

Table 5 decomposes the ranking into M , S , D , and L . The binding constraint is defined as the lowest component score, cross-checked against the largest contribution to scenario-specific readiness loss. The decomposition is more informative than the aggregate index because it identifies the type of reform most likely to raise readiness-enabling capacity.

The component decomposition shows why a single European readiness policy is unlikely to be efficient. In the Central-Western Industrial Core, the key problem is the conversion of industrial depth into certified surge output and sustained inventories, not the absence of industrial depth. In the Baltic-Polish Eastern Flank, the binding component is logistics and sustainment because proximity to likely attrition demand interacts with replenishment and infrastructure constraints. Among countries in the Black Sea–Balkans region, defence-industrial capability binds first, and logistics reinforces that constraint. In the Nordics and South-West Mediterranean, defence-industrial constraints arise from different sources: high-technology inputs and northern sustainment in the Nordics; naval sustainment, missile components, and energy-sensitive production in the South-West Mediterranean.

The decomposition also helps explain why reporting aggregates must be read carefully. The Central-Western Industrial Core has the highest M , S , and D values, but the lowest of its four components is L . This means that, relative to its own macroeconomic and industrial strength, the conversion of output into sustained inventories, maintenance, and replenishment is the component most likely to bind; it does not mean that allies in the reporting aggregate lack logistics in absolute terms. The Baltic-Polish Eastern Flank has a different profile. Its macroeconomic and sectoral values are not the lowest in the sample, but the logistics and sustainment component is weaker because the region is exposed to high attrition demand and forward sustainment requirements. This implies that raising the aggregate score requires improving the component that is low relative to the reporting aggregate's strategic exposure.

For the Nordics, the decomposition points to defence-industrial capability rather than macroeconomic capacity as the key issue. Fiscal capacity and institutional quality are strong, but high-technology inputs, maritime and air sustainment, missile components,

Table 5: Component decomposition and binding constraints by region

Region	<i>M</i>	<i>S</i>	<i>D</i>	<i>L</i>	Binding constraint	Policy interpretation
Nordics	0.72	0.66	0.58	0.61	<i>D</i>	Defence-industrial constraints linked to high-technology inputs, missile components, air/naval sustainment.
Baltic-Polish Flank	0.60	0.55	0.49	0.45	<i>L</i>	Logistics, stockpiles, and replenishment bind before macroeconomic capacity.
Industrial Core	0.79	0.73	0.70	0.65	<i>L</i>	Aggregate capacity is strong, but sustainment, certified surge output, and cross-border coordination bind.
South-West Med.	0.68	0.63	0.56	0.59	<i>D</i>	Defence-industrial bottlenecks are concentrated in naval sustainment, missile components, and energy-sensitive production.
Black Sea–Balkans	0.51	0.49	0.42	0.44	<i>D</i>	Production depth is the primary constraint, reinforced by infrastructure and logistics limits.

Notes: *M* denotes macroeconomic capacity, *S* sectoral resilience, *D* defence-industrial capability, and *L* logistics and sustainment. Scores are disclosure-controlled regional aggregates of country-level estimates. The binding constraint is the lowest component score, cross-checked against scenario-specific readiness loss.

and northern logistics can constrain readiness-enabling capacity. For the South-West Mediterranean, the intermediate aggregate score masks a concentration of vulnerabilities in naval sustainment, energy-sensitive production, missiles, and Mediterranean logistics. For countries in the Black Sea–Balkans region, the defence-industrial component is the lowest because production depth, supplier availability, certification, and infrastructure limits are more constraining than macroeconomic capacity alone.

7.3 Scenario comparison

Table 6 shows how the index changes across scenarios. The deterioration is largest under the combined multi-theatre stress scenario because geoeconomic fragmentation, supply-chain disruption, price and fiscal stress, attrition, and reduced external support occur together. Intermediate regions are most sensitive to scenario assumptions because their aggregate scores depend more heavily on the balance between external support, substitutability, and logistics.

The prolonged-rivalry scenario is least damaging because it assumes gradual de-risking and greater time for adaptation. The attrition-intensive and external-support-reduction scenarios generate larger losses for the Baltic-Polish Eastern Flank and countries in the Black Sea–Balkans region because the relevant constraints are concentrated in logistics, inventories, air defence, and replenishment. The supply-chain-fragmentation scenario has stronger effects on the Nordics and South-West Mediterranean than their baseline

Table 6: Readiness-enabling index by scenario

Region	BL	AT	PR	SCF	ESR	CMS	Main scenario sensitivity
Nordics	0.64	0.61	0.67	0.60	0.62	0.56	Supply-chain fragmentation, high-technology inputs, and external-support reduction.
Baltic-Polish Flank	0.52	0.46	0.55	0.50	0.47	0.39	Attrition, ammunition demand, air-defence replenishment, and external-support reduction.
Industrial Core	0.72	0.68	0.74	0.69	0.70	0.64	Surge capacity, certified output, and critical-electronics assumptions.
South-West Med.	0.62	0.58	0.64	0.59	0.60	0.53	Maritime sustainment, missile components, energy exposure, and Mediterranean logistics.
Black Sea–Balkans	0.46	0.40	0.48	0.43	0.41	0.34	Attrition, production depth, logistics, and air-defence replenishment.

Notes: BL denotes balanced baseline; AT attrition-intensive; PR prolonged rivalry; SCF supply-chain fragmentation; ESR external-support reduction; and CMS combined multi-theatre stress. Values are reporting aggregates and are intended for comparative diagnosis rather than operational ranking.

positions might suggest because high-technology inputs, missile components, and maritime systems depend on specialised supply chains. The combined multi-theatre stress scenario lowers all regions, but it does not eliminate the ordering: the strongest and weakest aggregate profiles remain robust, while the middle positions narrow.

7.4 Ranking changes under combined multi-theatre stress

Figure 2 shows how the baseline ranking changes under the combined multi-theatre stress scenario. The figure reports baseline and combined-stress values for each region. The combined-stress scenario lowers every region, but the magnitude of the decline differs. The largest absolute declines occur where attrition, external-support reduction, and limited production depth reinforce each other.

The figure reinforces the main empirical interpretation. The combined-stress scenario penalises reporting aggregates where multiple constraints bind simultaneously, rather than simply scaling all regions down proportionally. The Baltic-Polish Eastern Flank and countries in the Black Sea–Balkans region experience the largest declines because logistics, attrition, replenishment, and production-depth constraints interact. The Central-Western Industrial Core remains the strongest profile, but it loses capacity through surge-conversion and sustainment constraints. The Nordics and South-West Mediterranean remain in the middle, with different exposure channels.

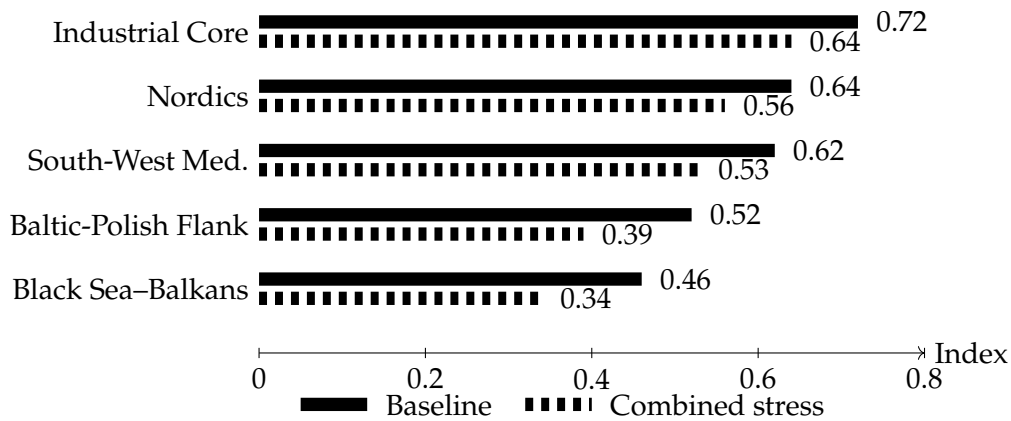


Figure 2: Ranking change under combined multi-theatre stress

7.5 Geographic interpretation

Countries in the Central-Western Industrial Core combine broad manufacturing capacity, large supplier networks, and macroeconomic depth, but their binding constraint is certified surge conversion. Output depends on contract credibility, skilled labour, production-line availability, testing, component certification, and cross-border coordination.

Nordic allies have strong macroeconomic and institutional capacity and important high-technology sectors. Their constraints are concentrated in specialised inputs, air and naval sustainment, missile components, northern logistics, and the ability to maintain platforms and munitions in demanding geography.

Analysed countries in the South-West Mediterranean occupy an intermediate position. Maritime sustainment, shipyard capacity, missile components, energy-sensitive production, Mediterranean logistics, and southern-theatre demands matter more than the aggregate score alone suggests.

Countries in the Baltic-Polish Eastern Flank and the Black Sea-Balkans region face more binding logistics, replenishment, and production-depth constraints. In the Baltic-Polish Eastern Flank, logistics and sustainment bind because countries in the reporting aggregate are exposed to high consumption rates, infrastructure stress, and external-support uncertainty. Countries in the Black Sea-Balkans region face limited production depth, weaker supplier networks, infrastructure constraints, logistics bottlenecks, and air-defence replenishment challenges. Across all reporting aggregates, the binding constraint is not always the component most visible in public debate: fiscal capacity, industrial assets, and strategic geography matter only insofar as they can be converted into certified surge output, inventories, maintenance, and replenishment.

8 Robustness and sensitivity

Table 7 reports sensitivity to alternative weights and missing-data assumptions. Table 8 summarises the wider robustness design, including exclusion of judgement-based indicators, scenario calibration, and aggregation from country to region. The purpose

is to identify which findings are robust to plausible changes in assumptions, not to find a single definitive score. The table reports the baseline score, the range under alternative weights, the range under low and high missing-data assumptions, and the data-confidence category.

Table 7: Sensitivity of index rankings to weights and missing data

Region	Baseline	Weight range	Missing-data range	Confidence	Interpretation
Nordics	0.64	0.60–0.68	0.61–0.67	Medium-high	Ranking sensitive to high technology input weights, but binding <i>D</i> constraint is stable.
Baltic-Polish Flank	0.52	0.47–0.56	0.48–0.55	Medium	Score sensitive to attrition and allied-availability assumptions; <i>L</i> remains central.
Industrial Core	0.72	0.68–0.75	0.69–0.74	High	Top ranking robust; uncertainty concerns speed of certified surge output.
South-West Med.	0.62	0.58–0.66	0.57–0.65	Medium	Relative position sensitive to energy exposure, maritime sustainment assumptions.
Black Sea–Balkans	0.46	0.40–0.50	0.41–0.49	Medium-low	Bottom ranking robust; uncertainty in the depth of local production and logistics proxies.

Notes: Ranges are derived from public reporting intervals in the central model. Confidence reflects proxy quality, missingness, and the extent to which country-level values rely on judgement-based defence-industrial variables. *M*, *S*, *D*, and *L* refer to macroeconomic capacity, sectoral resilience, defence-industrial capability, and logistics and sustainment.

The uncertainty is multidimensional. Measurement uncertainty arises because some indicators are proxies for unobservable stockpiles, lead times, supplier depth, and maintenance capacity. Aggregation uncertainty arises because country values can be combined by GDP, population, defence expenditure, or unweighted rules. Scenario uncertainty arises because stress multipliers, allied-availability assumptions, and component weights are maintained assumptions rather than estimates. Disclosure uncertainty arises because country-level results are not reported publicly, so the article emphasises broad patterns rather than country-specific claims.

The sensitivity results support three conclusions. First, the top and bottom of the distribution are stable. The Central-Western Industrial Core remains the strongest aggregate profile and countries in the Black Sea–Balkans region remain the most constrained reporting aggregate under alternative weights and missing-data assumptions. Second, the middle of the distribution is more sensitive. The Nordics and South-West Mediterranean can switch relative positions depending on the weight assigned to high-technology inputs, energy exposure, maritime sustainment, and external support. Third, the identity of the binding component is more robust than the exact aggregate score. This is important because policy sequencing depends more on the binding

Table 8: Robustness and sensitivity checks

Robustness dimension	Alternative specification	Reported statistic	Interpretation rule
Equal weights versus alternative weights	Compare equal component weights with scenario-specific weights and stress-adjusted weights	Score range; rank stability; binding-component stability	Robust if broad ranking and binding component remain stable.
Exclusion of judgement-based indicators	Recompute index excluding or down-weighting judgement-based defence-industrial variables	Difference from central score; change in confidence flag	Robust if inference remains stable after low-observability indicators are removed or down-weighted.
Treatment of missing values	Compare central imputation with low and high assumptions; adjust denominators for not-applicable indicators	Missing-data range; affected component	Robust if conclusions survive low/high assumptions.
Scenario calibration	Vary stress multipliers, allied-availability assumptions, surge-capacity assumptions, and component weights	Scenario-specific score range; largest deviation	Robust if the same scenario remains the main stress case.
Aggregation from country to reporting aggregate	Compare GDP-weighted, population-weighted, defence-expenditure-weighted, and unweighted aggregation	Reporting-aggregate score range; rank-change indicator	Robust if reporting-aggregate ordering and binding constraint remain stable across aggregation rules.

Notes: The table summarises the robustness checks used to assess whether the reporting-aggregate ordering and binding-constraint interpretation depend on weighting, judgement-based variables, missing-data assumptions, scenario calibration, or reporting aggregation.

component than on small differences in aggregate values.

9 Discussion

The analysis suggests that European readiness should be assessed through conversion capacity as well as through budgets and platform counts. The central issue is whether resources can be converted into certified production, usable inventories, maintenance capacity, spare parts, logistics, transport, and replenishment under stress. The framework highlights why the same budget increase can have different readiness effects across countries and scenarios.

9.1 Implications of findings

Three findings stand out. First, readiness-enabling constraints are component-specific. The binding component differs across regions, and the identity of the binding component is more policy-relevant than the aggregate ranking. Second, scenario assumptions matter. The combined multi-theatre stress scenario generates the largest losses because it combines fragmentation, attrition, price stress, and external-support reduction. Third, preparedness is path-dependent. Regions that enter a crisis with credible demand, qualified suppliers, inventories, maintenance capacity, and replenishment contracts face lower adjustment costs than regions that attempt to build capacity after the shock occurs.

The framework also highlights the importance of disclosure-controlled measurement. Country-level detail is analytically useful, but public country reporting could be potentially sensitive. Regional aggregates preserve enough variation to identify broad constraints while avoiding the disclosure of operationally relevant details. This design choice is both a confidentiality precaution and an analytical statement. The paper is about readiness-enabling constraints, not about assigning military grades to countries.

The limitations are material. Public data do not fully reveal stockpiles, maintenance backlogs, production bottlenecks, supplier contracts, or surge capacity. These variables need to be estimated, as explained in the online Appendix. Some defence-industrial variables require judgement-based scoring. Input-output data are often too aggregated to capture certified defence components. Missing-data treatment affects confidence. Scenario weights are assumptions, not estimates. The results are therefore best read as a structured diagnostic map. They identify where further classified validation, procurement analysis, or industrial-base assessment would have the highest value.

The comparative-static implication is to evaluate spending targets against conversion targets. Spending remains necessary and becomes sufficient only when it relaxes the binding conversion constraints. Conversion targets would ask whether a region can replace a specified inventory drawdown within a defined period; whether suppliers have qualified substitutes; whether framework contracts contain surge clauses; whether maintenance and spare parts can sustain high utilisation; whether transport corridors can handle crisis flows; and whether critical inputs can be sourced without strategic

competitors. These targets would make readiness-enabling capacity more measurable and more actionable.

A final implication is that European coordination should focus on bottlenecks rather than only on aggregate targets. Common procurement can raise readiness-enabling capacity when it creates credible demand and standardised replenishment. It can also worsen bottlenecks if many governments place orders for the same constrained inputs without coordinating suppliers, certification, or production sequencing. Industrial policy can raise capacity when it funds the scarce stage of production. It can also be ineffective if it expands assembly capacity while leaving energetic materials, electronics, test facilities, skilled labour, or maintenance bottlenecks unresolved. The index is useful because it forces this distinction: a policy should be evaluated by whether it relaxes the binding component.

The framework also suggests a different approach to monitoring. A readiness-monitoring framework should track lead times, supplier concentration, qualified substitutes, inventory rotation, maintenance backlogs, replenishment rates, transport capacity, and the fraction of procurement covered by credible multi-year contracts, not only defence expenditure or announced procurement. These indicators are less visible than spending totals, but they are closer to the conversion mechanism that determines readiness-enabling capacity under stress.

9.2 Comparative statics from the index

The simulations are comparative statics derived from the index. They show how the readiness-enabling score changes when one measured constraint is relaxed under maintained scenario assumptions. They do not estimate implementation costs, political feasibility, contractor behaviour, or full general-equilibrium effects. The purpose is to show whether a lever targets the binding component.

The table implies a sequencing logic rather than a universal reform package. Simulated gains are largest when a lever relaxes the binding component, unless a non-binding component is a prerequisite for relaxing it. If L binds because inventories are low, stockpile expansion and replenishment contracts are first-order constraints. If L binds because replenishment depends on unavailable inputs, supplier diversification or surge-capacity investment may be required first. If D binds because firms do not expect durable demand, framework contracts and credible multi-year procurement become central. If D binds because of missing critical inputs, industrial-base measures depend on sectoral resilience.

The interpretation would be weakened if classified validation showed that countries with low measured conversion capacity nevertheless maintain sufficient inventories, maintenance capacity, and replenishment contracts to absorb geoeconomic shocks without meaningful loss of readiness-enabling output. Conversely, the interpretation would be strengthened if classified stockpile, maintenance, supplier, and lead-time data confirmed the public-data binding components.

Table 9: Comparative statics and binding-component effects

Lever	Main component	Largest simulated gain	Interpretation
Stockpiles, spare parts, pre-positioning, replenishment contracts	<i>L</i>	Where logistics and sustainment bind	Raises resilience to attrition and external-support reduction.
Framework contracts, surge clauses, supplier qualification, production-line expansion	<i>D</i>	Where defence-industrial capability binds	Converts expected demand into capacity, subject to lead times, labour, testing, and inputs.
Supplier diversification, substitution, strategic reserves, critical-input monitoring	<i>S</i>	Under supply-chain fragmentation	Reduces exposure to concentrated suppliers when certification and substitution are feasible.
Multi-year fiscal planning, procurement smoothing, labour mobilisation	<i>M</i>	Where fiscal and labour constraints bind	Improves absorption capacity but cannot substitute for missing production or stocks.

Notes: Entries are comparative statics, not policy programmes. They indicate the direction and likely location of improvement in the readiness-enabling index under maintained assumptions. *M*, *S*, *D*, and *L* denote macroeconomic capacity, sectoral resilience, defence-industrial capability, and logistics and sustainment.

10 Conclusion

The main finding is that Europe's readiness challenge is a budgetary, force-structure, and economic-industrial conversion problem under strategic stress: the capacity to transform fiscal resources, industrial inputs, logistics networks, and procurement commitments into usable capability under stress. The paper develops a readiness-enabling index that combines macroeconomic capacity, sectoral resilience, defence-industrial capability, and logistics and sustainment. The results show that reporting-aggregate constraints differ sharply: some regions are limited by logistics and inventories, others by critical inputs and supplier depth, and others by the conversion of broad industrial capacity into certified surge output.

This changes how readiness should be assessed. A higher defence budget becomes equivalent to higher readiness-enabling capacity only when spending can be converted into production, maintenance, spare parts, inventories, transport, and replenishment before crisis conditions materialise. The relevant unit of analysis is therefore the chain that links fiscal capacity to usable output under stress, alongside the euro spent or the platform acquired. This paper ranks readiness-enabling constraints, not military effectiveness.

The next research frontier is to connect disclosure-controlled public measurement with classified validation and dynamic modelling. Future work should estimate lead-time distributions, model cross-border supplier dependencies, link stockpile drawdown to

replenishment contracts, evaluate the cost of surge capacity, and compare alternative procurement mechanisms. The central analytical task is to understand whether Europe can convert higher defence spending into sustained capability before geoeconomic stress arrives, not only whether Europe can spend more on defence.

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Online Appendix to Cold War 2.0 and Defence Readiness

1 Purpose and scope of the online appendix

This online appendix documents the technical material that supports *Cold War 2.0 and defence readiness*. It is deliberately narrower than the working-paper annexes. The main article treats countries as the unit of calculation and uses reporting aggregates only to summarise disclosure-controlled patterns. The appendix therefore retains the material needed to reproduce the readiness-enabling index, understand the scenario calibration, interpret uncertainty, and validate the ranking logic. Broader policy-programme material and extended sectoral discussion are omitted.

The empirical approach links defence economics, defence-industrial mobilisation, and geoeconomic supply-chain analysis. The defence-economics literature motivates the distinction between expenditure and usable defence output (Sandler and Hartley, 1995; Dunne, 1995; Hartley, 2007). Input-output and global-value-chain research motivates the treatment of shocks as propagated constraints rather than isolated price changes (Acemoglu et al., 2012; Antràs and Chor, 2013; Baldwin and Freeman, 2022; Baqaee and Farhi, 2024; Boehm et al., 2019; Bonadio et al., 2021). Critical-materials and industrial-resilience work motivates the screening of supplier concentration, substitutability and lead-time risks (European Commission, 2023; Graedel et al., 2015; Nassar et al., 2015; OECD, 2023). Recent work on defence preparedness and supply-chain resilience motivates the interpretation of the index as a readiness-enabling measure rather than as operational readiness itself (Kancs, 2025, 2026; Hellberg, 2026).

2 Indicators, transformations and uncertainty

The main article defines readiness-enabling capacity as an economic-industrial conversion problem. Table 1 records the indicator families, transformations and confidence flags used to operationalise that concept. The table is intentionally implementation-oriented: it separates the underlying concept from the transformed variable and from the confidence judgement attached to the public data.

Uncertainty enters the index through four channels. Measurement uncertainty arises when proxy indicators stand in for classified or proprietary information. Aggregation uncertainty arises because alternative weights and functional forms can change the relative importance of components. Scenario uncertainty arises because shock magnitudes, propagation assumptions and external-support constraints cannot be observed *ex ante*.

Table 1: Indicator categories, transformations, and sources

Component	Indicator category	Example raw measure	Transformation	Direction after transformation	Confidence flag	Sources
<i>M</i>	Fiscal and macroeconomic capacity	Fiscal balance, debt ratio, output exposure, inflation sensitivity	Normalise to 0–1; reverse-scale vulnerability measures; winsorise extreme values where needed	Higher = stronger	High, Medium, Low	Eurostat gov_10dd_edpt1, nama_10_a64, nama_10_a10, HICP, IMF WEO, ECB, OECD TIVA.
<i>M</i>	Labour and absorption capacity	Skilled labour availability, unemployment, defence-relevant workforce constraints	Normalise to 0–1; convert scarcity indicators so higher values denote stronger absorption capacity	Higher = stronger	High, Medium, Low	EU-LFS, Eurostat lfsa_eisn2, Job Vacancy Statistics, SBS, NA, CEDEFOP.
<i>S</i>	Input concentration and supplier dependence	Import concentration, Herfindahl indices, dependency on restricted suppliers	Reverse-scale concentration; combine direct and indirect exposure; apply substitutability adjustment	Higher = stronger	High, Medium, Low	BACI, Comtrade, Comext, Eurostat, PRODCOM.
<i>S</i>	Critical-material and technology exposure	Critical raw materials, semiconductors, electronics, explosives precursors, specialised machine tools	Reverse-scale dependency; adjust for inventories, substitutes, and domestic or allied supply	Higher = stronger	High, Medium, Low	EU CRM list, JRC RMIS, NA, PRODCOM, SBS.
<i>D</i>	Supplier depth and production capacity	Number and diversity of qualified suppliers, production-line availability, platform or component capacity	Normalise to 0–1; apply confidence flag where capacity is proxy-based or judgement-based	Higher = stronger	High, Medium, Low	Eurostat SBS, National Accounts, TED, national procurement portals, Orbis, OpenCorporates, ASAP, classified data.
<i>D</i>	Lead times, certification, and surge conversion	Delivery lead times, testing capacity, certification bottlenecks, surge activation share	Reverse-scale lead times; adjust surge capacity by activation factor and bottleneck constraints	Higher = stronger	High, Medium, Low	TED, national portals, audit reports, procurement panel, EDA, NATO, STANAG, MoDs, ASAP, classified data.
<i>L</i>	Inventories, stockpiles, and spare parts	Inventory adequacy, stockpile rotation, spare-parts availability, munitions replenishment	Normalise to 0–1; use low/central/high assumptions where stocks are not public	Higher = stronger	High, Medium, Low	Classified data, obtained through controlled NATO channels.
<i>L</i>	Maintenance, transport, and pre-positioning	Maintenance capacity, repair backlog, transport corridors, port/rail resilience, pre-positioned stocks	Normalise to 0–1; reverse-scale congestion or bottleneck measures; aggregate by region	Higher = stronger	High, Medium, Low	Classified data, obtained through controlled NATO channels.

Notes: The table reports indicator categories, transformations, and principal source families used to construct the readiness-enabling index. *M*, *S*, *D*, and *L* denote macroeconomic capacity, sectoral resilience, defence-industrial capability, and logistics and sustainment. Cells marked for completion can be updated as source-specific model documentation is finalised.

Disclosure uncertainty arises because the public article reports groups of countries rather than country-level values. Tables 2–6 therefore document the main sensitivity checks used to support the robustness section of the article.

Table 2: Robustness to alternative component weights

Region	Equal weights	Scenario weights	Alternative weights	Rank change	Comment
Nordics	0.67	0.61	0.68	2–3–2	Falls one rank under scenario weights but remains in the upper tier; the substantive finding is unchanged.
Baltic-Polish Flank	0.55	0.52	0.50	4–4–4	Rank is stable; weaker logistics and sustainment keep the region below the middle tier across weights.
Industrial Core	0.74	0.69	0.73	1–1–1	Rank is robustly first; weighting changes affect levels but not the leading position.
South-West Med.	0.66	0.63	0.65	3–2–3	Moves ahead of the Nordics only under scenario weights; the region remains close to the upper-middle group.
Black Sea–Balkans	0.44	0.46	0.46	5–5–5	Rank is robustly lowest; weighting changes do not remove the binding production-depth and logistics constraints.

Notes: The table compares equal weights, scenario weights, and an alternative weighting specification. Rank change reports the ordering under the three specifications in the order shown. *M*, *S*, *D*, and *L* denote macroeconomic capacity, sectoral resilience, defence-industrial capability, and logistics and sustainment.

3 Macroeconomic and sectoral exposure channels

This section records how geoeconomic shocks enter the macroeconomic and sectoral components of the index. The key modelling choice is to evaluate how fiscal space, price pressures, energy exposure, import dependence and input-output linkages can affect the ability of European countries to absorb defence expansion. This follows the article’s argument that spending commitments are converted into readiness-enabling capability through constrained industrial and logistical systems, not through budgets alone.

4 Defence-industrial and supply-chain exposure

The defence-industrial module translates sectoral exposure into constraints on certified production, surge capacity, maintenance, repair, replenishment and stockpile build-

Table 3: Robustness to excluding judgement-based indicators

Region	Central score	Partial judgement-based indicators	Excluding judgement-based indicators	Difference	Interpretation
Nordics	0.62	0.67	0.61	-0.01	Exclusion has a negligible effect; the finding is not driven by judgement-based variables.
Baltic-Polish Flank	0.52	0.54	0.49	-0.03	Score falls moderately, indicating that judgement-based sustainment proxies partly support the central estimate.
Industrial Core	0.75	0.73	0.70	-0.05	Score declines but remains high; leadership is robust to excluding less observable industrial variables.
South-West Med.	0.59	0.61	0.63	+0.04	Score improves when judgement-based indicators are excluded, suggesting conservative central scoring for some sustainment variables.
Black Sea–Balkans	0.49	0.44	0.45	-0.04	Exclusion lowers the score; the constrained classification remains unchanged.

Notes: The table compares the central score with variants that partially or fully exclude judgement-based indicators. The difference column reports the change from the central score to the specification excluding judgement-based indicators. Positive values indicate that the exclusion raises the regional score.

Table 4: Robustness to missing-data treatment

Region	Low	Central	High	Affected component	Comment
Nordics	0.60	0.65	0.66	S/D	Results are moderately sensitive to assumptions on high-technology inputs and certified surge capacity.
Baltic-Polish Flank	0.51	0.56	0.51	L	Central estimate is somewhat higher; low and high cases both confirm logistics and sustainment as binding.
Industrial Core	0.68	0.69	0.68	D	Missing-data treatment has little effect; the region's relative position is highly stable.
South-West Med.	0.62	0.62	0.61	L/D	Score is almost invariant; missing data do not materially change the interpretation.
Black Sea–Balkans	0.50	0.43	0.46	D/L	Results are sensitive in level but not in classification; production depth and logistics remain binding.

Notes: Low, central, and high refer to alternative assumptions for missing or weakly observed inputs. The affected component column reports the component most influenced by missing-data treatment; *S* denotes sectoral resilience, *D* defence-industrial capability, and *L* logistics and sustainment.

Table 5: Robustness to scenario calibration

Region	Central CMS	Lower stress	Higher stress	Largest affected component	Comment
Nordics	0.67	0.62	0.63	S/D	Stronger calibration lowers the score through input and surge-capacity constraints, but not enough to alter the upper-tier classification.
Baltic-Polish Flank	0.56	0.51	0.49	L/D	Higher stress magnifies ammunition, air-defence replenishment and logistics constraints.
Industrial Core	0.68	0.73	0.71	D	Level varies with surge-conversion assumptions, but the region remains the least constrained profile.
South-West Med.	0.64	0.63	0.63	L/D	Scenario calibration has a small effect; naval, air and missile sustainment remain the relevant margins.
Black Sea–Balkans	0.48	0.47	0.45	D/L	Higher stress slightly worsens an already constrained profile; interpretation is unchanged.

Notes: CMS denotes combined multi-theatre stress. Lower and higher stress report alternative calibrations around the central CMS specification. The largest affected component identifies the component most sensitive to calibration; *S*, *D*, and *L* denote sectoral resilience, defence-industrial capability, and logistics and sustainment.

Table 6: Robustness to regional aggregation methods

Region	GDP-weighted	Defence-expenditure-weighted	Population-weighted	Un-weighted	Interpretation
Nordics	0.63	0.61	0.67	0.65	Population weighting lifts the score, while defence-expenditure weighting is lower; the region remains upper-middle.
Baltic-Polish Flank	0.50	0.55	0.48	0.49	Defence-expenditure weighting raises the score, but aggregation choice does not remove the sustainment constraint.
Industrial Core	0.69	0.71	0.69	0.69	Aggregation choice has almost no effect; the regional result is highly robust.
South-West Med.	0.66	0.65	0.64	0.59	Unweighted aggregation is lower, indicating within-region heterogeneity; weighted results remain in the middle tier.
Black Sea–Balkans	0.50	0.43	0.43	0.44	GDP weighting raises the score, but all variants indicate a constrained regional profile.

Notes: The table compares aggregation methods for reporting country-level estimates at the regional level. GDP-weighted, defence-expenditure-weighted, population-weighted, and unweighted aggregation are used to assess whether the regional interpretation is driven by a small number of large countries.

Table 7: Macroeconomic and sectoral exposure concepts

Concept	Variable	Interpretation
Macroeconomic exposure	$ME_c^k, \Delta X_c^k$	Economy-wide sensitivity to trade, price, output and fiscal shocks.
Direct sectoral exposure	$DE_{c,s}^k$	Direct dependence of a country-sector pair on risk-bloc import availability.
Indirect sectoral exposure	$IE_{c,s}^k$	Upstream dependence through input-output linkages.
Total sectoral exposure	$E_{c,s}^k$	Combined direct and indirect exposure.
Sectoral vulnerability	$V_{c,s}^k$	Exposure adjusted for supplier concentration, substitutability, defence relevance.

Notes: The table separates exposure from vulnerability. Exposure identifies where a shock enters the economy; vulnerability identifies where exposure is difficult to absorb, substitute, or offset. These concepts inform the M and S components of the readiness-enabling index.

Table 8: Data requirements for macroeconomic and sectoral exposure analysis

Data type	Data sources	Use in the model
Macroeconomic accounts	Eurostat, OECD, national accounts	Baseline GDP, GNE, domestic absorption, prices and fiscal-space indicators.
Input-output tables	OECD ICIO, WIOD	Upstream exposure, sectoral propagation and indirect risk-bloc dependence.
Bilateral trade data	Eurostat, UN Comtrade, BACI/CEPII	Direct import and export exposure by partner and sector.
Critical materials and components	EC CRM, USGS, trade classifications, firm-level sources	Identification of concentrated inputs and materials not visible in aggregate IO sectors.
Weights defence relevance	NATO, SIPRI, procurement data	Mapping from civilian sectors to defence-readiness relevance.

Notes: The table distinguishes data available from public statistical systems from data that require supplementary sources, expert judgement, or proxy variables. The resulting indicators are mapped primarily to macroeconomic capacity (M) and sectoral resilience (S).

Table 9: Exposure-ranking outputs for empirical implementation

Output	Unit of observation	Ranking interpretation
Top exposed sectors	Country–sector pair NACE Rev. 2 / ISIC Rev. 4 2-digit and, where available, 3- or 4-digit	Identifies sectors with the highest direct and indirect exposure to risk-bloc trade, input-output linkages and scenario-specific shocks.
Top exposed HS products	Country–product pair at HS 6, with HS 4 robustness aggregation	Identifies critical materials, components or specialised inputs where trade dependence is concentrated and substitutability may be limited.
Vulnerability country-sector scores	Country–sector pair combining $E_{c,s}^k$, $C_{c,s}$, $\sigma_{c,s}$ and $R_{c,s}^D$	Ranks sectors by exposure adjusted for concentration, substitutability and defence relevance.
Defence-relevant exposure list	Country–sector–product mapping linking NACE, ISIC sectors to HS 6 products	Identifies which sector-level vulnerabilities are driven by specific product-level dependencies.
Scenario sensitivity ranking	Country–sector or country–product pair across low, central and high scenario variants	Shows which vulnerabilities remain robust across calibration assumptions and which are scenario-specific.

Notes: The outputs guide the transition from macroeconomic and sectoral exposure analysis to the defence-industrial and supply-chain assessment. Rankings are computed separately for each scenario and then compared across scenarios.

up. The module is designed to capture bottlenecks that are especially relevant under geoeconomic stress: critical inputs, concentrated suppliers, limited substitutability, long qualification cycles, small production runs and competition between national demand signals.

Table 10: Critical-input screening criteria

Criterion	Interpretation
Strategic input relevance	The input is used in a defence-relevant production category, platform, subsystem or maintenance process.
Supplier concentration	Production, processing or export capacity is geographically concentrated or dominated by a small number of suppliers.
Low substitutability	Alternative inputs or suppliers require redesign, qualification, certification or performance trade-offs.
Long lead time	Replacing the input requires new production capacity, tooling, testing, export licences or regulatory approval.
Inventory thinness	Existing stocks are limited relative to crisis demand, replenishment needs or target-stock requirements.
Scenario sensitivity	The input becomes more binding under CRINK fragmentation, external capability diversion or combined multi-theatre stress.

Notes: The criteria identify inputs that warrant detailed defence-industrial assessment. HS 6 denotes six-digit Harmonized System product codes. Product-level inputs are mapped back to NACE or ISIC sector groups for integration with sectoral exposure measures.

5 Model implementation and scenario calibration

The main article reports the results in compact form. This section records the notation and calibration logic needed to reproduce the article’s headline findings. The baseline index combines four components: macroeconomic capacity, sectoral resilience, defence-industrial capability, and logistics and sustainment. Scenario shocks are applied as reductions in readiness-enabling capacity through the relevant components. They are interpreted as comparative-statics exercises derived from the index, not as forecasts or operational scenarios.

6 Concordances and capability mappings

The article relies on several concordances linking macro-sectoral data, product-level trade classifications and defence-industrial capability categories. These concordances are used to identify where general economic exposure is likely to become defence-relevant. The mapping is intentionally conservative: it identifies exposure channels that can constrain readiness-enabling capacity, but it does not infer classified stockpile levels, operational availability or combat effectiveness.

Table 11: Defence-industrial exposure indicators

Indicator	Unit	Interpretation
Defence-industrial output loss	Country–category	Estimated production loss in a defence-industrial category after applying sectoral exposure and defence relevance weights.
Critical-input exposure	Country–HS 6 product	Risk-bloc dependence adjusted for concentration, substitutability and defence relevance.
Supplier-risk score	Country–HS 6 product or category	Screening score combining critical-input exposure, supplier concentration and substitutability.
Production bottleneck index	Country–category	Combined measure of crisis demand, effective capacity, lead times, supplier risk.
Target-stock achievement time	Country–capability item	Time required to reach the target stock under scenario-specific production and lead-time assumptions.
Readiness gap	Country–capability item	Delay beyond the scenario horizon required to achieve the target stock.

Notes: The indicators are used for ranking and stress testing within the defence-industrial capability component (*D*). They identify where additional defence-industrial data, expert validation, or sensitivity analysis are required.

Table 12: Defence-critical input ranking outputs

Output	Unit of ranking	Intended interpretation
Top exposed HS products	Country–HS 6 product	Identifies products with high risk-bloc import dependence or high scenario-specific trade-availability shocks.
Top supplier-risk products	Country–HS 6 product	Identifies products where exposure is amplified by supplier concentration and low substitutability.
Top bottleneck categories	Country–defence-industrial category	Identifies categories where crisis demand exceeds effective production capacity or where supplier-risk scores are concentrated.
Target-stock delays	Country–capability item or production category	Identifies where the time required to achieve the target stock exceeds the scenario horizon.
Binding-input map	HS 6 product–production category pair	Links narrow product dependencies to munitions, missiles, air systems, naval systems, ground systems, C4ISR or maintenance.
Policy-action flag	Vulnerability type	Indicates the primary policy response: stockpiling, diversification, surge-capacity investment, procurement contracting or standardisation.

Notes: The ranking outputs are used for stress testing and policy triage. They are produced by scenario and compared across low, central, and high shock calibrations.

Table 13: Core assumptions for defence-industrial exposure assessment

Parameter	Interpretation	Main empirical basis	Treatment
$Q_{c,g}^B$	Baseline production capacity for country c and defence-industrial category g .	Procurement data, industrial-production data, company reports, delivery schedules and expert judgement.	Use observed capacity; calibrate as a range.
$Q_{c,g}^S$	Nominal surge capacity above baseline production.	Defence-industrial studies, mobilisation plans, framework contracts, workforce and tooling constraints.	Treat as uncertain and scenario-sensitive.
$\phi_{c,g}$	Share of nominal surge capacity that can be activated at the speed of relevance.	Expert judgement, historical ramp-up evidence, contract terms and bottleneck assessment.	Sensitivity parameter bounded between zero and one.
$L_{c,g}$	Production, procurement, qualification or delivery lead time.	Procurement documents, delivery records, firm reports, known bottlenecks and expert judgement.	Use item-specific estimates; apply low, central and high assumptions.
$S_{c,g}^*$	Target stock required under scenario-specific readiness assumptions.	Policy targets, NATO planning assumptions, open-source estimates and scenario design.	Treat as scenario-specific and often partly classified.
$\sigma_{c,h}$	Product- or input-level substitutability.	Alternative supplier availability, technical qualification requirements, performance constraints.	Sensitivity parameter; lower values increase vulnerability.
$R_{c,s}^D, R_{c,h}^D$	Defence relevance of a sector or product.	Procurement categories, firm-level production links, expert screening and capability taxonomy.	Weighting parameter linking economic exposure to readiness relevance.

Notes: g denotes a defence-industrial production category and h an HS 6 product or critical input. Parameters with weak empirical observability are estimated as ranges and assessed in sensitivity analysis.

Table 14: Core notation and empirical interpretation

Symbol	Unit or range	Interpretation	Data source, parameterisation
c	Country	European ally or country unit in the analysis	NATO member country list and national statistical data.
s	Sector	NACE/ISIC sectors in macroeconomic and input-output analysis	OECD ICIO, WIOD, and Eurostat SUT.
h	Product	HS 6 product or critical input	UN Comtrade, BACI/CEPII, national trade data.
g	Capability category	Defence-industrial production category	Capability taxonomy and procurement data.
k	Scenario	Baseline, CRINK fragmentation, capability diversion, combined shock	Scenario design in Section 3.
$M_{c,h}^{R,k}$	Currency or quantity	Imports from risk-bloc suppliers under scenario k	Bilateral trade data and scenario shocks.
$DE_{c,h}^k$	$[0, 1]$	Direct sectoral import exposure	Sectoral trade and production data.
$IE_{c,s}^k$	$[0, 1]$	Indirect exposure through input-output linkages	Input-output coefficients.
$V_{c,s}^k$	Index	Sectoral vulnerability score	Exposure, criticality, substitutability and defence relevance.
$CE_{c,h}^k$	Index	Critical-input exposure score	HS 6 dependence, concentration, substitutability and defence relevance.
$HH_{c,h}^k$	$[0, 1]$	Supplier concentration index	Product-level import shares by supplier.
$\sigma_{c,h}$	$[0, 1]$	Substitutability of product h	Econometric estimates, certification requirements and supplier availability.
$Q_{c,g}^{B,k}$	Output per period	Baseline production capacity	Production, delivery and procurement data.
$Q_{c,g}^{S,k}$	Output per period	Nominal surge capacity	Industrial mobilisation evidence and expert judgement.
$\phi_{c,g}$	$[0, 1]$	Share of surge capacity usable within the crisis horizon	Activation assumptions and bottleneck analysis.
$Q_{c,g}^{E,k}$	Output per period	Effective production capacity	$Q_{c,g}^{B,k} + \phi_{c,g} Q_{c,g}^{S,k}$
$L_{c,g}^k$	Time	Lead time for production, delivery or qualification	Procurement records, firm reports and expert judgement.
$S_{c,g}^0$	Stock units	Initial stock	National inventories, classified data or proxies.
$S_{c,g}^{*,k}$	Stock units	Scenario-specific target stock	Readiness targets, sustainment assumptions and scenario design.
$T_{c,g}^k$	Time	Target-stock achievement time	Lead time plus production time required to close target-stock gap.
$R_{c,a,t}^k$	$[0, 1]$	Readiness score for country c , capability area a and time t	Normalised macro, sectoral, industrial and sustainment components.

Notes: Variables with limited observability are computed with confidence ranges and low, central, and high assumptions. R denotes the readiness-enabling index; M , S , D , and L denote macroeconomic capacity, sectoral resilience, defence-industrial capability, and logistics and sustainment.

Table 15: Scenario calibration ranges

Scenario	Trade volume θ^M	Trade cost θ^c	Substitutability θ^o	Capacity θ^B, θ^S	Lead time θ^L	Target stock θ^{S^*}	Calibration sources
CRINK fragmentation	0.25–1.00 for selected risk-bloc flows	0.10–0.75	0.10–0.40	0.05–0.30	0.10–0.50	0.10–0.25	Data-based for trade exposure; literature-based for fragmentation ranges; sensitivity parameter for substitutability and capacity.
Indo-Pacific diversion	0.05–0.20 for relevant systems and inputs	0.05–0.25	0.05–0.20	0.05–0.40	0.20–0.75	0.10–0.40	Literature- and expert-based for external capability diversion; sensitivity parameter for lead times and stock targets.
Middle East diversion	0.05–0.15 for affected inputs and logistics	0.05–0.30	0.05–0.15	0.05–0.30	0.10–0.50	0.05–0.25	Literature- and expert-based for capability profile; data-based where energy, logistics or trade-cost channels are included.
Combined multi-theatre stress	0.50–1.00 for selected risk-bloc flows	0.25–1.00	0.20–0.50	0.10–0.60	0.40–1.50	0.25–0.75	Scenario-combination and sensitivity parameter; should be stress-tested rather than interpreted as a central forecast.
Managed de-risking variant	Reduction of 0.10–0.40 in exposure shock	Lower by 0.05–0.25	Higher by 0.20–0.60 relative to crisis case	Capacity loss lower by 0.05–0.25	Lead-time shock lower by 0.10–0.50	Pre-funded or pre-stocked 0.25–0.50	Policy-simulation assumption; requires sensitivity analysis and later empirical calibration.

Notes: Ranges are stress-test inputs and are complemented by empirical calibration where evidence permits. Calibration values should be interpreted as scenario assumptions rather than estimates of realised shocks.

Table 16: Scenario comparison and binding variables

Scenario	Main shock channel	Main readiness effect	Binding variable	Interpretation
Baseline	No additional strategic shock	Reference readiness	None by construction	Measures pre-shock readiness and existing structural gaps.
China-centred trade shock	Electronics, critical materials, batteries, machinery and maritime trade	Lower sectoral resilience and defence-industrial capability	S, D	Highlights dependence on critical inputs and industrial substitutability.
Russia escalation	Energy, eastern-flank logistics, ammunition demand and air-defence demand	Higher sustainment needs and replenishment pressure	D, L	Highlights munitions, air defence, logistics and maintenance constraints.
Dual-front crisis	Simultaneous trade fragmentation and European security escalation	Broad-based readiness loss	M, S, D, L	Tests whether macroeconomic, industrial and logistics systems can absorb compound shocks.
Maritime disruption	Shipping costs, port disruption, undersea infrastructure risk and import delays	Reduced availability of imported inputs and delayed replenishment	S, L	Highlights chokepoints in trade, transport, energy and spare-parts availability.
Technology-denial scenario	Semiconductors, sensors, software, cyber and C4ISR restrictions	Reduced production and upgrade capacity for advanced systems	D, S	Highlights dependence on high-technology inputs and certification-intensive substitution.
External-support reduction	Lower US availability, delayed allied support or capability diversion	Higher domestic sustainment and production burden	D, L, M	Tests European ability to sustain readiness with less external reinforcement.

Notes: The table summarises each scenario by main shock channel, readiness effect, and binding variable. Binding variables are used to interpret changes in the readiness-enabling index rather than to predict operational outcomes.

Table 17: Scenario calibration summary

Model parameter	Implementation in model	Baseline	CRINK fragmentation	Indo-Pacific capability diversion	Middle East capability diversion	Combined multi-theatre stress	Calibration source
$\theta_{c,h}^M$	Reduction in risk-bloc import availability	0	0.60–1.00	0.10–0.25	0.05–0.15	0.70–1.00	Trade restrictions, blockade assumptions and risk-bloc exposure.
$\theta_{c,h}^\tau$	Increase in trade costs	0	0.20–0.50	0.15–0.35	0.10–0.25	0.30–0.70	Freight costs, tariff-equivalent barriers and transport disruption.
$\theta_{c,h}^\sigma$	Reduction in substitutability	0	0.20–0.50	0.10–0.30	0.05–0.20	0.30–0.60	Certification, technical constraints and supplier availability.
$\theta_{c,g}^B$	Reduction in baseline production capacity	0	0.05–0.15	0.00–0.10	0.00–0.08	0.10–0.25	Energy, labour, input and facility constraints.
$\theta_{c,g}^S$	Reduction in surge capacity	0	0.10–0.25	0.05–0.20	0.05–0.15	0.20–0.40	Sub-supplier, workforce and tooling constraints.
$\theta_{c,g}^L$	Increase in lead time	0	0.30–0.80	0.20–0.60	0.10–0.40	0.60–1.50	Procurement delays, certification delays and logistics disruption.
$\theta_{c,g}^{S,g}$	Increase in target-stock requirement	0	0.20–0.60	0.30–0.90	0.20–0.70	0.70–1.50	Scenario-specific readiness targets and sustainment assumptions.
$\theta_{c,g}^A$	Reduction in external allied availability	0	0.05–0.15	0.25–0.60	0.15–0.45	0.40–0.80	Capability-diversion assumptions and access constraints.

Notes: Scenario calibration combines country-specific evidence, maintained scenario assumptions, and expert judgement. Calibration is used for comparative stress testing and is not an estimate of conflict probability.

Table 18: Sector groups for macroeconomic and defence-relevant exposure analysis

Sector group	Sector/product detail	Macroeconomic relevance	Defence-readiness relevance	Examples of exposed inputs/outputs
Basic metals and fabricated metal products	NACE Rev. 2 / ISIC Rev. 4 divisions 24–25; HS chapters 72–83, with HS 6 for alloys and metal inputs	High exposure to energy, raw materials and trade costs	Armour, barrels, shells, vehicles and shipbuilding inputs	Steel, aluminium, titanium, tungsten, specialised alloys, tubes, forgings and castings.
Chemicals and non-metallic materials	NACE Rev. 2 / ISIC Rev. 4 divisions 20 and 23; HS chapters 28–40, with HS 6 for explosives, propellants and specialised chemicals	Input-intensive and energy-sensitive	Explosives, propellants, composites and protective materials	Nitrocellulose, energetic materials, carbon fibre, ceramics, adhesives, resins and speciality chemicals.
Electronics, electrical equipment and optics	NACE Rev. 2 divisions 26–27; ISIC Rev. 4 divisions 26–27; HS chapters 84–85 and 90, with HS 6 for semiconductors, sensors and optical equipment	High global value-chain exposure	Sensors, radars, communications, guidance, drones, cyber and space systems	Semiconductors, printed circuit boards, rare earth magnets, optical components, antennas and batteries.
Machinery and transport equipment	NACE Rev. 2 divisions 28–30; ISIC Rev. 4 divisions 28–30; HS chapters 84–89, with HS 6 for engines, turbines and vehicle components	Strong input-output linkages	Vehicles, engines, ship systems, aircraft components and logistics equipment	Engines, turbines, bearings, machine tools, propulsion components, aircraft parts and vehicle subsystems.
Energy and fuels	NACE Rev. 2 sections B, D and division 19; ISIC Rev. 4 sections B, D and division 19; HS chapter 27 at HS 6 for product detail	Macroeconomic price and supply channel	Operating tempo, production costs and industrial resilience	Gas, electricity, refined fuels, fuel additives, coke, petroleum products and electricity inputs.
Logistics, transport and storage	NACE Rev. 2 / ISIC Rev. 4 section H; product-level trade where transport equipment is separately coded	Trade and delivery channel	Procurement timelines, stockpile movement and maintenance supply	Ports, shipping, rail, air cargo, warehousing, maintenance logistics and distribution services.
Information, software and professional services	NACE Rev. 2 sections J and M; ISIC Rev. 4 sections J and M; product detail uses services classifications where available	Smaller material footprint but high enabling value	Command systems, software integration, cyber, testing and certification	Software, systems engineering, secure cloud, testing services, certification and specialised engineering support.

Notes: NACE Rev. 2 or ISIC Rev. 4 at the two-digit level is used for macroeconomic and input-output analysis because it aligns with OECD ICIO, WIOD, and national accounts. HS 6 is used for product-level exposure to critical materials, components, and specialised defence-relevant inputs; HS 4 is used for robustness checks or where HS 6 concordance is noisy.

Table 19: Sector-product concordance workflow

Step	Output	Common pitfalls
Sector grouping	NACE/ISIC sectors to macro-sector groups	Over-aggregation can hide narrow defence-relevant dependencies.
Product mapping	HS 6 products linked to NACE/ISIC sectors	Concordance noise can misclassify multi-use products.
Screening of defence-relevance	HS 6 products assigned defence-relevance flags	Expert judgement is required for dual-use and classified inputs.
Capability mapping	Products linked to capability categories	One product can support several capability families.
Aggregation	Country-sector-product-capability exposure score	Weighting choices can affect rankings.

Notes: The workflow maps product-level exposure to sector-level and capability-level indicators. HS 4 aggregation is used as a robustness check where HS 6 product coding is noisy or unstable.

6.1 Readiness-score construction and inventory equations

The index combines component scores after normalisation to a common readiness-oriented scale. Higher values represent stronger readiness-enabling capacity. The baseline country-level score for scenario k , country c , capability area a and time t is:

$$R_{c,a,t}^k = \alpha_M M_{c,t}^k + \alpha_S S_{c,a,t}^k + \alpha_D D_{c,a,t}^k + \alpha_L L_{c,a,t}^k, \quad (1)$$

where $\alpha_M + \alpha_S + \alpha_D + \alpha_L = 1$. Adverse indicators are transformed so that higher values correspond to stronger readiness-enabling capacity:

$$\hat{x}_c^k = \frac{x_c^k - \min_c x_c^k}{\max_c x_c^k - \min_c x_c^k}, \quad \tilde{x}_c^k = 1 - \hat{x}_c^k. \quad (2)$$

Where natural thresholds exist, threshold normalisation is preferred:

$$\tilde{x}_c^k = \min \left\{ \frac{x_c^k}{x_c^*}, 1 \right\}, \quad (3)$$

where x_c^* is the readiness-relevant threshold. Effective production capacity is represented as:

$$Q_{c,g}^{E,k} = Q_{c,g}^{B,k} + \phi_{c,g} Q_{c,g}^{S,k}. \quad (4)$$

The scenario-specific target-stock gap and target-stock achievement time are:

$$G_{c,g}^k = S_{c,g}^{*,k} - S_{c,g}^0, \quad T_{c,g}^k = L_{c,g}^k + \frac{\max\{G_{c,g}^k, 0\}}{Q_{c,g}^{E,k}}. \quad (5)$$

The readiness gap relative to the scenario horizon is:

$$RG_{c,g}^k = \max\{T_{c,g}^k - H^k, 0\}. \quad (6)$$

Table 20: Defence-industrial production categories and exposure channels

Production category	Sector and product codes	Main civilian-sector links	Main exposure channels	Readiness relevance
Munitions and energetics	NACE Rev. 2 / ISIC Rev. 4 divisions 20, 24–25 and 28; HS chapters 28–29, 36, 73, 76 and 93, especially HS 6 for explosives, propellants and ammunition	Chemicals, fabricated metals, machinery, logistics	Explosives, propellants, metal casings, fuzes, packaging, storage and certification	Replenishment of artillery ammunition, missiles, interceptors and other high-consumption items.
Missiles, air defence and precision systems	NACE Rev. 2 / ISIC Rev. 4 divisions 20, 25–28 and 30.3; HS chapters 84–85, 88, 90 and 93, especially HS 6 for semiconductors, radar, guidance, optics and propulsion inputs	Electronics, optics, electrical equipment, machinery, chemicals	Guidance components, sensors, propulsion, semiconductors, rare earth magnets, energetic materials	Critical for deterrence, air and missile defence, long-range fires and saturation resilience.
Ground systems and vehicles	NACE Rev. 2 / ISIC Rev. 4 divisions 24–30; HS chapters 72–87, 90 and 93, especially HS 6 for armour materials, engines, transmissions, bearings and vehicle parts	Basic metals, fabricated metals, machinery, transport equipment, electronics	Armour steel, engines, transmissions, sensors, optics, tracks, tyres and electronic subsystems	Affects availability, replacement, maintenance and modernisation of armoured and protected mobility systems.
Air systems and unmanned systems	NACE Rev. 2 / ISIC Rev. 4 divisions 26–30, especially 30.3; HS chapters 84–85, 88 and 90, including HS 8806 for unmanned aircraft, HS 8507 for batteries and HS 8526 for radio-navigation equipment	Aerospace, electronics, software, optics, machinery	Airframes, engines, avionics, sensors, batteries, composites, secure communications	Affects air capability, drones, ISR, logistics, training and maintenance capacity.
Naval and maritime systems	NACE Rev. 2 / ISIC Rev. 4 divisions 24–28 and 30.1; HS chapters 72–85, 89 and 90, especially HS 6 for turbines, propulsion, cables, radar and ship components	Shipbuilding, machinery, electronics, steel, energy systems	Steel, turbines, propulsion, sensors, radars, sonars, cables and port capacity	Affects naval presence, sea control, maritime logistics and undersea infrastructure protection.
Space, cyber and C4ISR	NACE Rev. 2 / ISIC Rev. 4 divisions 26 and 61–63, plus professional services in section M; HS chapters 84–85 and 90 for hardware, with services classifications for software and systems integration	Electronics, optics, software, professional services, telecommunications	Semiconductors, sensors, secure cloud, software integration, testing and specialist skills	Provides strategic enablers for command, surveillance, targeting, communications and resilience.
Maintenance, repair and overhaul	NACE Rev. 2 / ISIC Rev. 4 divisions 33, 45, 52 and 71; HS spare-parts codes in chapters 84–90 and 93, depending on platform or subsystem	Machinery, transport services, professional services, spare parts supply	Spare parts, skilled labour, diagnostics, repair facilities, certification and logistics	Determines whether existing stocks and platforms remain usable under stress.

Notes: The codes provide the basis for empirical mapping. NACE Rev. 2 or ISIC Rev. 4 are used for sector-level production and input-output analysis, while HS 6 is used for product-level exposure to critical materials, components, and specialised defence-relevant inputs. HS 4 is used for robustness checks where HS 6 product definitions or concordance mappings are unstable. The categories provide a modelling bridge between sectoral exposure, product-level dependencies, and readiness-relevant production constraints; they are not a complete defence-industrial taxonomy.

Table 21: Data requirements and sources for defence-industrial and supply-chain exposure

Data block	Possible sources	Use in the model	Main limitation
Defence procurement and spending	NATO, EDA, SIPRI, national budgets, procurement plans	Defence relevance weights, demand categories and baseline procurement patterns	Aggregation and limited comparability across countries.
Industrial production and firms	Eurostat, national statistics, company reports, industry associations	Production capacity, sector mapping and industrial concentration	Firm-level capacity often incomplete, commercially sensitive.
Critical materials and components	European Commission CRM data, USGS, UN Comtrade, BACI, HS 6 trade data	Critical-input exposure, supplier concentration and product-level dependency	HS codes often do not identify specialised defence-grade inputs.
Lead times and surge capacity	Procurement documents, delivery schedules, defence-industrial studies, expert judgement	Target-stock achievement time and bottleneck indicators	Many values require assumptions, expert validation.
Inventories and target stocks	NATO, OSINT estimates, policy targets, scenario design	Initial stocks, target stocks, replenishment and stockpile build-up	Classified or unavailable for many categories.
Maintenance and spare parts	Military Balance+, procurement contracts, company reports, logistics data	Availability of existing systems under stress	Often less visible than platform acquisition.

Notes: The table distinguishes observable public data from parameters that require additional assumptions. Assumption-sensitive parameters are assessed in sensitivity analysis and mapped primarily to defence-industrial capability (D) and logistics and sustainment (L).

Table 22: Capability taxonomy for empirical implementation

Capability family	Subcategories	NACE/ISIC sector links	HS product lines	Main bottleneck type
Munitions and energetics	Artillery shells, rockets, mortar rounds, propellants, explosives, fuzes and casings	Chemicals; basic metals; fabricated metals; machinery	HS 28-29, 36, 72-76 and 93	Energetics, metal inputs, storage, certification and high consumption.
Missiles and air defence	Interceptors, rocket motors, seekers, guidance, launch systems and radars	Electronics; optics; chemicals; machinery; aerospace	HS 84-85, 88, 90 and 93	Long lead times, low substitutability and specialised components.
Ground systems	Armoured vehicles, artillery platforms, engines, transmissions, tracks, optics and spare parts	Metals; machinery; motor vehicles; electronics	HS 72-87, 90 and 93	Engines, transmissions, armour, maintenance, spare parts.
Air systems and unmanned systems	Aircraft components, drones, avionics, batteries, sensors and communications	Aerospace; electronics; electrical equipment; software; optics	HS 84-85, 88, 90; HS 8806, 8507, 8526	Batteries, sensors, avionics, composites, MRO and certification.
Naval and maritime systems	Vessels, shipyards, propulsion, turbines, sensors, cables and maritime logistics	Shipbuilding; metals; machinery; electronics; ports	HS 72-85, 89 and 90	Shipyard capacity, propulsion, sensors and long build cycles.
C4ISR, space and cyber	Communications, satellites, secure cloud, software integration, sensors and cyber defence	Electronics; telecommunications; software; professional services	HS 84-85 and 90; services classifications	Semiconductors, secure communications, skills and systems integration.
Maintenance, repair and overhaul	Spare parts, diagnostics, depot repair, test equipment and upgrades	Repair; machinery; transport; professional services	HS 84-90 and 93 spare-parts codes	Skilled labour, diagnostics, spare-parts depth and repair throughput.

Notes: The taxonomy is a concordance device for this study and is not a complete force-planning taxonomy. It links defence-industrial categories, critical inputs, and readiness-relevant constraints for empirical implementation.

These equations separate stock depth, usable production capacity and lead time. A comparative-static improvement reduces the readiness gap only if it raises initial stocks, increases effective certified capacity, shortens lead time or relaxes the binding component in the conversion chain.

7 Missing data, reporting aggregates and disclosure control

The unit of calculation is the country. Reporting aggregates are used only to present disclosure-controlled results and to identify broad patterns of constraint. The aggregation procedure is therefore a reporting and confidentiality device, not a claim that regions are unified actors or homogeneous defence economies. Countries in the Black Sea–Balkans region, the Baltic–Nordic region, Central–Eastern Europe and Western–Mediterranean Europe can share exposure patterns, but the underlying scores are calculated at country level.

Table 23: Missing-data coding and treatment

Missing-data type	Treatment	Interpretation
Not applicable	Exclude from denominator	Variable not relevant for the country, sector or capability category.
Unavailable public data	Use proxy and confidence flag	Estimate is informative but should be reported as lower confidence.
Classified data	Use restricted calibration where authorised or open-source range otherwise	Result distinguishes true vulnerability from limited observability.
Commercially sensitive data	Use firm reports, procurement proxies or expert elicitation	Confidence depends on triangulation across sources.
No plausible proxy	Report as unknown	No mechanical imputing where no defensible information exists.

Notes: Empirical rankings compute readiness-enabling indices together with data-confidence indicators. Low, central, and high cases are used where missingness or proxy quality could affect regional scores.

8 Comparative-static intervention support

The main article retains one compact comparative-statics table. The appendix records the underlying scenario sensitivity in a concise form. The entries below are not programme recommendations and do not estimate welfare effects. They show how different intervention types affect the binding components of the readiness-enabling index under alternative shock assumptions.

Table 24: Regional reporting groups

Reporting region	Countries included in country-level computation
Nordics	Denmark, Finland, Iceland, Norway and Sweden.
Baltic-Polish Flank	Estonia, Latvia, Lithuania and Poland.
Industrial Core	Belgium, Czechia, France, Germany, Luxembourg, Netherlands, Slovakia and the United Kingdom.
South-West Med.	Italy, Portugal and Spain.
South-East Europe and the Black Sea-Balkans	Albania, Bulgaria, Croatia, Hungary, Montenegro, North Macedonia, Romania and Slovenia.

Notes: Country-level computations are retained for calibration and validation. Public outputs are reported only for the five regions shown to reduce sensitivity around country-specific vulnerabilities and to avoid implying precise national rankings.

9 Robustness, validation and reporting outputs

The robustness strategy focuses on the stability of headline findings rather than on a single definitive score. It checks whether binding components, relative exposure patterns and scenario losses remain broadly similar under alternative weights, missing-data treatments, judgement-exclusion tests and scenario calibrations. The interpretation would be weakened if independent or classified validation showed that countries with low measured conversion capacity nevertheless maintain sufficient inventories, maintenance capacity and replenishment contracts to absorb geoeconomic shocks without meaningful loss of readiness-enabling output.

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Table 25: Comparative-static intervention sensitivity across scenarios

Comparative-static intervention	Baseline	CRINK fragmentation	Indo-Pacific diversion	Middle East diversion	Combined stress	Interpretation
Critical-input monitoring and HS 6 supplier screening	Medium	High	Medium	Medium	High	Robust package because it improves visibility across most trade and supply-chain shocks.
Strategic stockpiling of munitions and interceptors	Medium	Medium	High	High	High	Most valuable when replenishment and air-defence demand bind quickly.
Dual sourcing and supplier qualification	Medium	High	Medium	Medium	High	Particularly important when risk-bloc dependence and supplier concentration drive vulnerability.
Surge-capacity and framework contracts	Medium	High	High	High	High	Robust package because it raises effective capacity and reduces uncertainty for firms.
European enabler and sustainment investment	Low	Medium	High	Medium	High	Scenario-sensitive package that becomes more important when external support is delayed or diverted.
Standardisation and joint procurement	Medium	Medium	Medium	Medium	High	Structural package with larger effects under combined stress and fragmented European demand.

Notes: Entries indicate relative priority, not measured intervention effectiveness. Comparative-static priority is derived from $\Delta R_{c,a}^k(p)$, urgency, feasibility, implementation cost, and time to readiness effect.

Table 26: Sensitivity-analysis matrix

Sensitivity dimension	Alternative assumptions	Output to compare
Scenario severity	Low, central and high shocks	Change in readiness-enabling index and bottleneck ranking.
Weighting scheme	Balanced, attrition-intensive, prolonged-rivalry and supply-chain-fragmentation weights	Stability of country and capability rankings.
Product detail	HS 6 versus HS 4	Stability of critical-input rankings.
Sector detail	NACE/ISIC 2-digit versus finer detail where available	Stability of sectoral exposure rankings.
Substitutability	Low, central and high $\sigma_{c,h}$	Change in critical-input exposure and bottleneck scores.
Surge capacity	Low, central and high $\phi_{c,g}$	Change in effective capacity and target-stock time.
Lead times	Low, central and high $L_{c,g}$	Change in replenishment and stockpile build-up delays.
Policy packages	Alternative cost, feasibility and time-to-effect assumptions	Stability of policy-priority scores.

Notes: Sensitivity analysis computes ranges, rank stability, and binding-component stability. These diagnostics complement point estimates and are used to assess whether findings depend on weights, missing data, scenario calibration, or aggregation.

Table 27: Validation sources and model variables

Validation source	Model variable	Validation use
Procurement data	Lead times, delivery rates, contract changes and backlog indicators	Check whether high $L_{c,g}^k$, low $Q_{c,g}^{E,k}$ or high $RG_{c,g}^k$ correspond to observed delays and emergency procurement.
Expert interviews	Defence relevance weights, substitutability and capability mapping	Validate $\omega_{c,s,g}^D$, $\sigma_{c,h}$, capability taxonomy assignments and bottleneck interpretation.
Firm reports	Capacity constraints, sub-supplier constraints, investment plans and production expansion	Validate $Q_{c,g}^{B,k}$, $Q_{c,g}^{S,k}$, $\phi_{c,g}$ and reported surge-capacity assumptions.
Known bottlenecks	Critical inputs, munitions, energetics, air defence, semiconductors, rocket motors, propulsion and spare parts	Check whether model-ranked bottlenecks correspond to independently observed capability constraints.

Notes: Validation checks whether rankings, signs, and bottleneck categories are consistent with independent evidence. It does not require disclosure of classified values.

Table 28: Reporting exposure and readiness results

Region	Score	Binding category	Main indicator	Interpretation
Nordics	0.64	Munitions, C4ISR and air/naval sustainment	$CE_{r,h}^k = 0.58$, $Tr_{r,g}^k = 4.8$ years	Moderate readiness with binding exposure in high-technology inputs and northern sustainment.
Baltic-Polish Flank	0.52	Air defence, ammunition and forward logistics	$RG_{r,g}^k = 2.9$ years, $G_{r,g}^k = 0.43$	Low readiness driven by high demand, thin stocks and rapid replenishment pressure.
Industrial Core	0.72	Critical electronics and surge capacity	$Q_{r,g}^{E,k} = 0.71$, $SR_{r,h}^k = 0.46$	Stronger industrial base, but electronics and surge capacity remain binding under combined stress.
South-West Med.	0.62	Naval sustainment and missile components	$L_{r,g}^k = 1.34L^0$, $CE_{r,h}^k = 0.51$	Moderate readiness with maritime and energy-sensitive production exposure.
South-East Europe, Black Sea–Balkans	0.46	Air defence, logistics and production depth	$Q_{r,g}^{E,k} = 0.44$, $RG_{r,g}^k = 3.6$ years	Low readiness caused by limited domestic production depth and long replenishment timelines.

Notes: Regional values of the readiness-enabling index are computed from country-level results and reported only after disclosure-control checks. Public reporting uses regional aggregates and should not be interpreted as country rankings.

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