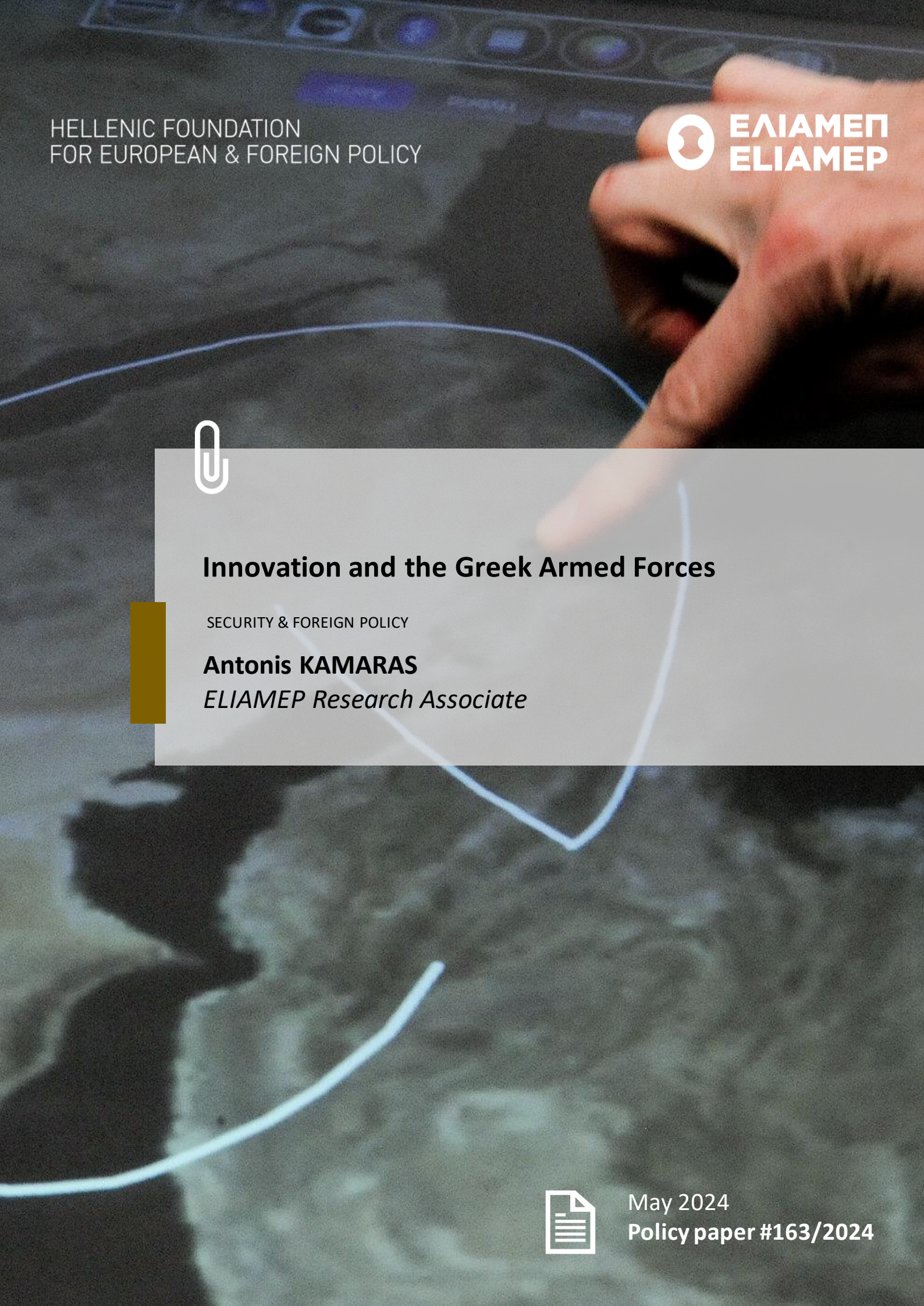

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Innovation and the Greek Armed Forces

SECURITY & FOREIGN POLICY

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May 2024
Policy paper #163/2024

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Summary

- The Legislation initiated by the Ministry of National Defence (MND) means that the Greek state will fund a long-term effort to spur innovation for the purpose of strengthening the battlefield efficacy of the country's Armed Forces.
- Greece's nexus of Venture Capital firms (VCs) and deep tech start-ups, as well as its extant Defence Technological Industrial Base, are well capable of utilizing the funding that will be made available by the MND, along with the opportunities that arise to test, validate and produce innovative defence products and services.
- Yet, wide-ranging changes in the way Greece's Armed Forces train, operate and manage their human resources will need to take place to enable the innovation engendered to take seed in fertile soil.
- Training needs to be better funded and be more realistic, particularly in the conscript-based Hellenic Army, so that innovation can be co-created.
- Professionals from all Services need to participate in multilateral missions that involve combat, so that their ability and aptitude to pursue battlefield-relevant innovation is meaningfully strengthened.
- Compensation for highly-skilled professional officers and other ranks needs to be raised, so that the MND can hold on to the human capital which can co-create and utilize innovative defence products and services.

Introduction

The passage of legislation institutionalising the relationship between the Ministry of National Defence (MND) and the Greek Armed Forces, on the one hand, with Greece's innovation ecosystem on the other, accompanied by the appointment of a technocratic-leaning Armed Forces leadership which can implement this policy agenda, is shifting the paradigm in Greece in two profoundly interdependent ways[1].

Greece's historically weak industrial base has not permitted the institutionalisation of home-grown innovation in military technologies, a legacy which the current leadership of Greece's defence establishment is seeking to leave behind.

First, this legislation assigns a primary role to Greece's innovation ecosystem in the introduction of innovation into the Greek Armed Forces and its evolution therein—a role which, throughout the two hundred and some years of the Greek nation-state's existence, has been monopolized by the acquisition of advanced weapon systems from abroad. Greek military officers have not only proved capable of overseeing weapons procurement from abroad in an exemplary fashion, they have also drawn on their own experience to contribute innovative improvements and designs to the weapon systems selected[2]. However, Greece's historically weak industrial base has not permitted the institutionalisation of home-grown innovation in military technologies, a legacy which the current leadership of Greece's defence establishment is seeking to leave behind.

Second, the legislation will, over time, make MND and the Greek Armed Forces the leading client of Greece's innovation ecosystem via a variety of national and multilateral funding streams (the latter mostly of EU origin, as NATO resources are considerably smaller) in the service of a single objective: enhancing the battlefield effectiveness of the Greek Armed Forces. Hitherto, Greece's innovation ecosystem has lacked an institutional partner of this sort, and there have been no stable funding sources directed at a tangible national objective, be it of an economic or public policy nature.

To evaluate the importance of this development, what it can deliver, and what it requires to succeed, this policy paper will begin in the first section by reviewing global developments relating to policy efforts directed in other democracies at harnessing national innovation ecosystems to the cause of innovation-driven, and thus battlefield-effective, Armed Forces.

The second section will evaluate the overall state of Greece's innovation ecosystem and identify strengths and weaknesses as these may relate to innovation and the Greek Armed Forces.

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[1] See, Σχέδιο Νόμου, Έρευνα, Ανάπτυξη και Καινοτομία στις Ένοπλες Δυνάμεις, εκσυγχρονισμός θεσμικού πλαισίου των ΑΣΕΙ και λοιπές διατάξεις, *Υπουργείο Εθνικής Άμυνας*, Μάρτιος 2024 [Draft Law, Research, Development and Innovation in the Armed Forces, modernization of Higher Level Military Education Institutions and other provisions, *Ministry of National Defence*, March 2024]. The new Chief of the Hellenic National Defence General Staff, as a special forces officer with a specialization in signals and a Ph.D. in IT from the prestigious Metsoveio Polytechnic, personifies the government's policy intent, see Β. Νέδος και Σ. Παπαντωνίου, Αλλαγή σελίδας στις ΕΔ, *Καθημερινή*, 13.12.2024 [V. Nedos and S Papantoniou, Change of Page in the Armed Forces, *Kathimerini*, 13.12. 2024]. The Minister of National Defence has explicitly linked the selection of the Chief of the HNDGS and of the three Service Chiefs with the Ministry's innovation-focused agenda, see Δήλωση ΥΕΘΑ Ν. Δένδια για την επιλογή της νέας ηγεσίας των Ενόπλων Δυνάμεων από το ΚΥΣΕΑ, 12.1.2024, ΥΕΘΑ [Statement of the Minister of National Defence on the selection of the new leadership of the Armed Forces by the Government Council of External Affairs and Defence, 12.1.2024, MND].

[2] For an early example, see how the Greek Armed Forces selected their main artillery gun in 1907 through field tests pitting competing European arms manufacturers against each other, J. A. Grant, *Rulers, Guns and Money – The Global Arms Trade in the Age of Imperialism*, Harvard University Press, 207, pp. 212-213. This example is also notable for the innovation-prone attitude of the Greek officer corps, which was constantly engaged in warfare in the 19th and 20th centuries, seeing as prior to the selection of the French Schneider gun, one of the most distinguished Greek officers of that era, Greek Army Colonel Panagiotis Danglis, actually helped Schneider to develop the artillery gun (the 76 mm M1909 mountain gun) which would go on to achieve wide adoption by other Armed Forces, see Wikipedia, 76 mm mountain gun M1909 and Πρόσωπα και Ιστορίες, Παναγιώτης Δαγκλής – Υπέρμαχος της εθνικής σύμπνοιας, *Καθημερινή*, 2.2.2024 [People and Stories, Panagiotis Danglis-Advocate of National Unity, *Kathimerini*, 2.2.2014].

The third section will examine Greece's Defence Technological Industrial Base (DTIB) and its capacity to partner effectively with the MND and the Greek Armed Forces, in view of the need to support the Greek military with home-grown innovation.

The fourth section will relate the MND and Greek Armed Forces' expectations of the Greek innovation ecosystem to their own inclination and capacity to introduce home-grown innovation into their mission and performance as a key component of their overall effectiveness.

The fifth section will make a number of policy recommendations, informed by the prior analysis, to the MND and the Greek Armed Forces.

The sixth section will sum up the policy paper's key argument.

Innovation and the Armed Forces of other democracies: learning from the US and Ukraine

…the US national security establishment is consumed by the worry that, unless it manages to establish an effective relationship with its civilian-use driven innovation ecosystem, the US would be at risk of losing its military superiority.

There are two main interconnected trends at play, which have put the issue of how innovation, which has been generated hitherto by civilian-use-focused ecosystems, centre-stage to the effort to enhance the battlefield effectiveness of militaries worldwide. In turn, these trends have created the literature and track record of interaction which can help us understand and evaluate the Greek effort.

The first trend is driven by US fears of ceding its military superiority to the People's Republic of China (PRC), due to its inability to innovate at a sufficient speed and scale. The second trend is the furious pace of military innovation utilized and co-created by the Ukrainian Armed Forces, and engendered by the war between Ukraine and the Russian Federation.

Regarding the first trend, as the foreword to a report put it, co-authored by an ex-Secretary of the US Department of Defense, and emblematic of this policy concern, "the US does not have an innovation problem but rather an innovation adoption problem"[3].

Without exaggeration, the US national security establishment is consumed by the worry that, unless it manages to establish an effective relationship with its civilian-use driven innovation ecosystem, the US would be at risk of losing its military superiority over the PRC and thus risk defeat in a possible conventional war, with Taiwan being the major bone of contention and the South China Sea the future battlefield. This worry has been grounded in the perception that China, while the US was distracted by wars of choice in counterinsurgency, has developed missile technology that negates the edge gained by the US Armed Forces in the post-WW II period. Not incidentally, such supreme emblems of US military superiority, established during WW II, as the battle carrier group are increasingly perceived as being vulnerable to China's increasingly capable conventional missile force[4].

The US's fears of losing its military superiority have been accompanied by a collective awareness of the military value of the nonpareil innovation capacity of Silicon Valley, its ecosystem of globally dominant IT companies, and the stream of highly innovative start-ups it creates. The conviction that has arisen is that, as a generator of innovation, Silicon

[3] Atlantic Council, Commission on Defense Innovation Adoption – Interim Report, April 2023.
[4] For a representative analysis of this concern, see M. Wortman, "Floating Pointlessness": Is this the end of the age of the Aircraft Carrier?, *Vanity Fair*, 5.6.2023.

Valley does indeed have the ability to render the US Armed Forces unquestionably dominant once again over any other adversary, the PRC included. For this to happen, however, the US DoD and Armed Forces need to render the relationship with civilian-led innovation functional with the help of suitable legislation and appropriation instruments.

Such functionality relates to whether the US DoD, the Armed Forces and their component Services can identify, select and deploy innovative technologies at the 'speed of relevance', meaning within a time frame in which these technologies can give the US Armed Forces an edge over rival Armed Forces, which are also presumed to be innovating at a rapid pace. For a typical statement of the perception of what is at stake, in the incorporating of civilian-led innovation into the US Armed Forces, we could no worse than quote the following statement on Artificial Intelligence (AI): "whichever military first masters organizing, incorporating and institutionalizing the use of data and AI into its operations in these coming years will be able to reap exponential advantages […]. The first adopter of AI at scale is likely to have a faster decision cycle and better information on which to base decisions, its networks are likely to be more resilient under attack, preserving its ability to maintain situational awareness, defend its forces, engaging its targets effectively, and protect the integrity of its command, control and communications"[5].

… accountability in procurement and the career incentives of procurement officials, as these are presently constituted, are viewed as being incompatible with the linking of civilian-led innovation with the US Armed Forces.

What are the main barriers to innovation which originates in the civilian realm making the leap over into the military realm? In the US, we would identify two.

First, a ponderous, time-consuming procurement process that is grounded in the need for democratic accountability in expending fiscal resources and compounded by risk aversion on the part of procurement officials[6]. This procurement process is inimical to both the funding and the nature of innovation, privileging 'compliance over outcomes'. Start-ups in particular cannot survive a long lead time of two years minimum before developing a product and having it purchased, given that in defence there is a single client, the DoD, not multiple ones[7]. Furthermore, as innovation has by its very nature a high failure rate, it endangers the career prospects of any procurement officers who take a wager on particular types of innovation and then sees them fail—even if an initial failure is actually a necessary step in the evolution of a highly successful defence product or service[8]. Effectively, accountability in procurement and the career incentives of procurement officials, as these are presently constituted, are viewed as being incompatible with the linking of civilian-led innovation with the US Armed Forces.

Second, by privileging the allocation of scarce fiscal resources to tried and tested weapon platforms, a powerful constellation of stakeholders deny resources to the nurturing and deployment at scale of innovative defence products and services. This constellation of stakeholders typically include high-ranking officers who have advanced professionally

[5] M. A. Flournoy, AI is already at War – How Artificial Intelligence will transform the military, *Foreign Affairs*, November / December 2023

[6] For an examination of this issue see, J. Hurst, Fixing Defense Innovation: Rewriting acquisition and security regulations, *War on the Rocks*, 7.10.2022, T. Kinder, How Silicon Valley is helping the Pentagon in the AI arms race, *Financial Times*, 31.7.2023 and M. A. Fulnroy and W. R. Anderson, How to leverage America's software advantage in the decisive age, *Breaking Defense*, 13.5.2023

[7] For an analysis of how the economics of smaller size innovative firms clash with the DoD's procurement processes see, R. Olney, The rift between Silicon Valley and the Pentagon is economic, not moral, *War on the Rocks*, 8.1.2018 and S. Blank, As Silicon Valley tries to enlist, the Pentagon strangles innovation, *War on the Rocks*, 15.4.2022. From a DoD / Armed Forces perspective on how safeguards must be put in place to prevent unethical vendors charging exorbitant amounts for subpar products and services relating to AI, see N. Dockery, Getting Artificial Intelligence right: the cautionary tale of the Defense Departments counter-IED fight, *Modern War Institute*, 20.6.2023

[8] For a discussion of the criticality of managing innovation failure in such a way that it actually becomes integral to successful innovation in defence, as exemplified in particular by the institutional envy of military innovation worldwide, the US DoD's famed Defense Advanced Research Projects Agency (DAPRA), see S. R. Soare and F. Pothier, Leading edge: key drivers of defence innovation and the future of operational advantage, *The International Institute for Strategic Studies*, November 2021., pp. 17-25.

through such legacy platforms, political interests which privilege the continuous investment in the manufacturing and upgrade of these platforms, which benefit those of their districts which host the industrial plants that produce them, as well as the defence prime contractors that actually produce the said legacy platforms. A prime example of this phenomenon is the disequilibrium between (a) expenditures committed to manufacturing such manned surface vessels as US Navy (USN) aircraft carriers and destroyers and (b) expenditures committed to the USN programme developing a range of unmanned sea vehicles and other non-conventional platforms, with a knowledgeable observer describing the latter, in comparison to the former, as "the dust particle in the pocket line of the budget"[9].

These barriers have resulted in a highly unbalanced relationship between the amount of private capital being channelled into defence-related start-up firms and the amount being spent on procurement in contracts awarded by the DoD to these start-ups[10]. It is indicative of the recognition of this challenge, for the US defence establishment and for private actors interested in promoting what they see as an effective, innovation-driven relationship with the DoD and the US Armed Forces, that cross-disciplinary research centres have been established in the US whose primary focus in investigating and designing solutions fit for this challenge. Two such centres are Stanford University's Gordian Knot Center for National Innovation and Georgetown University's Center for Security and Emerging Technology[11].

In contrast, the US's main rival, the PRC, is seen as having effected a formidable military-civil fusion in recent years, whereby innovation is not encumbered by democratic accountability constraints and resources are generously directed at weapon systems that are seen as capable of challenging the historical primacy of the US Armed Forces[12]. In that regard, the absence of a legacy of military dominance, primarily via emblematic weapon systems, is seen as an advantage, as the PRC can develop counter-measures to such weapon systems without having to contend with pressure groups that have been built up over decades of proven performance of such weapon platforms as, for example, aircraft carriers.

…the defence-related innovation generated by Ukraine, despite the country's entrenched corruption and weak governance, is placed in the analytical context of how an existential threat can mobilize national resources.

We shall now move on to the second trend: the experience of innovation in the battlefields of Ukraine. As a democratic state fighting to survive and relying on the US for the bulk of its military assistance, Ukraine has both starkly outlined the constraints analysed above on integrating civilian-led innovation into the US Armed Forces, and highlighted the opportunities for such integration when constraints become suspended under the exigency of war.

This conventional, peer-to-peer war, which has been ongoing for two years and is expected to last for at least one more, has demonstrated how fast—and, often, at how little cost—military-relevant innovation can take place once peacetime constraints are no longer in place, in terms of regulations governing procurement and the testing and evolution of technologies in the field. For our investigation, the defence-related

[9] E. Lipton, Faced with evolving threats, US Navy struggles to change, *New York Times*, 4.9.2023.
[10] To give an order of magnitude, in terms of the financial interests and innovation potential vested in a functional relationship between Silicon Valley and the DoD, we mention that defence technology firms outside the main prime defence contractors received $ 135 billion in investments and acquisitions in 2016-2022, see PitchBook, *Vertical Snapshot: Defense Tech*, 2023 Report Preview. McKinsey, the global management consultancy firm, has divided start-up growth in defence in the US into three phases, with wave one in 2002-2010 involving 22 seed-funding rounds, wave two in 2011-2017 involving 466 funding rounds, and wave three in 2028-2023 involving 849 funding rounds in the following domains: sensing, connectivity and security; advancing computing and software; space technology; biotechnology; and autonomous systems, see J. Klempner, C. Rodriguez, D. Swartz, A rising wave of tech disruptors: The future of defence innovation?, *McKinsey & Company*, 22.2.2024.
[11] The web sites of these two research centres are indicative of the mission, https://gordianknot.stanford.edu/ and https://cset.georgetown.edu/
[12] See, E. White and S. Yu, Xi Jinping's dream of a military industrial complex, *Financial Times*, 18.6.2023

innovation generated by Ukraine, despite the country's entrenched corruption and weak governance, is placed in the analytical context of how an existential threat can mobilize national resources and exploit capacities which were latent in peacetime[13]. This analytical context is inherently present in the Greek case, as well[14].

Critically, the war in Ukraine has demonstrated how crisis conditions accelerate innovation in two ways. First, through the efforts generated by the technical abilities of a developed industrial society with a well-educated population, a vibrant pre-war start-up high-tech sector, and a coherent public policy of state digitization. Second, through the involvement in the war effort of US IT global leaders such as Google and Microsoft, as well as newly-created US tech companies like Palantir and Starlink which are more narrowly defence-oriented or defence-relevant: i.e. the same innovative corporate cohort the US views as critical to its efforts to reground its military supremacy in an expanded innovation universe that far exceeds the boundaries of prime defence contractors such as Lockheed Martin or Boeing[15].

As a result, the war in Ukraine has generated a coherent body of critical self-reflection within the US defence establishment, as well as elsewhere in other Western defence establishments, on how slow the Armed Forces of Western democracies have been to test and integrate innovation into their operations. It is worth briefly reviewing two prominent examples of this critique.

First, the delay of the US Armed Forces in introducing relevant systems and technologies in the era of the mass usage of first person view (FPV) drones of mostly civilian origin ushered in by the Russo-Ukrainian war. Due to primarily bureaucratic impediments, the US Army has to date failed to procure such cheap FPV drones en masse (in their tens of thousands) and put them in the hands of fielded units so they can experiment with them relentlessly and, in due course, introduce the more sophisticated capacities these drones need to meet exacting requirements in terms of anti-Electronic Warfare resilience and so on[16]. Committed as it is to highly expensive manned aircraft such as the F35, which were developed in the 20th century, the US Air Force has also failed to develop solutions for the so-called air littoral, the air space from the ground to ten thousand feet in which drones of various capabilities operate. As a result, "US ground forces have now essentially lost the protective top cover that the Air Force provided through air superiority for decades"[17].

Second, this critique has been inspired by the way in which Ukraine's Armed Forces have managed to render more effective the so-called 'sensor to shooter kill chain'—the process of locating and attacking the enemy—by integrating open-source data, satellite imagery, drone footage and reports from the ground, partly with the help of AI[18]. This achievement, which utilizes civilian assets such as Starlink satellites, public interest civilian geolocation apps predating the war, and civilian start-up expertise, has extra resonance for the US IT community. This is because it reflects their own commercial experience of software not as a product sold once, at a particular point in time, but as an on-going service procured by

[13] J. Thornhill, How 'creative insecurity' is stimulating Ukrainian innovation, *Financial Times,* 10.8. 2023.
[14] The author argued in favour of employing the analysis of the seminal work by P. Z. Taylor, *The Politics of Innovation – why some countries are better than others at science and technology*, Oxford University Press, 2016, in a previous policy paper on the future prospects of the Greek defence sector, see Antonis Kamaras, The Greek Defence Sector? Turning the page?, Policy Paper 126, *ELIAMEP*, February 2023, p. 18.
[15] See, indicatively, V. Bergengruen, How tech giants turned Ukraine into an AI War Lab, *TIME*, 8.2.2024
[16] See, Tyler Hacker, How the US Army can close its dangerous – and growing – small drone gap, *Modern War Institute*, 03.6.24
[17] D. Barno and N. Beshael, Drones, the air-littoral, and the incoming irrelevance of the US Air Force, *War on the Rocks*, 7.3.2024.
[18] See, indicatively, S. G. Jones, R. McCabe, and A. Palmer, Ukrainian Innovation in a war of attrition, *Center for Strategic and International Studies*, CSIS Briefs, February 2023

a client, whereby IT is tested, deployed, adjusted and redeployed; neither the DoD nor the component Armed Forces Services are seen as having mastered this iteration yet.

The Greek Research Ecosystem: weaknesses and strengths

We have seen how, for the most innovative nation in the world, the US, the main obstacle to adopting innovation in the defence realm lies in procurement processes and commitments to legacy weapon systems. In the case of Greece, our starting point is inescapably the reverse: namely, the country's very poor track record in innovation overall and, more specifically, in technology transfer from the country's research ecosystem to either private or state entities.

… Greece is an outlier, for its level of development, in the paucity of its university & industry links, ranking 118th out of a total of 132 countries.

According to the Global Innovation Index 2023, Greece is an outlier, for its level of development, in the paucity of its university & industry links, ranking 118th out of a total of 132 countries[19]. Only two other EU member states—Croatia and Slovakia—are not included in the first 100 countries in this key metric, with only five high-income countries in total ranked lower than 100: the three EU member states, Greece included, plus Panama and Trinidad & Tobago.

In a related point, while Greece performs in line with its overall score on the Global Innovation Index 2023, two of its neighbours, Bulgaria and—critically—Turkey, are doing roughly twice as well in terms of university and industry links.

	Greece	Turkey	Bulgaria
Overall Global Innovation Index Ranking 2023	42	39	38
University and industry links Global Innovation Index Ranking 2023	118	76	53

This poor performance in research & industry links and in the generation of applicable knowledge does not mean that Greece is also behind in the generation of intellectual capital.

Other corroborating figures are Greece's very low performance in patent registration, with just 157 patent applications (or 15 applications per million of population) in 2023, compared with a median of 150 patents per million of population. This places Greece 90% below the European median[20] in patent registration, which is of course a key metric in the commercialization of intellectual production.

This poor performance in research & industry links and in the generation of applicable knowledge does not mean that Greece is also behind in the generation of intellectual capital. Greek research teams do well in participations in competitive EU research consortia, ranked 8th in the EU-27 according to the number of participations, and its performance in the category of scientific and technical articles per billion PPP$ GDP and the Citable documents H-Index are both described as 'strong' by the Global Innovation Index 2023, with Greece achieving 19th and 29th place respectively out of 132 countries worldwide[21].

[19] World Intellectual Property Organization, *Global Innovation Index 2023-Innovation in the face of uncertainty*, 2023
[20] Δ. Δελεβέγκος, Ουραγός στην Ευρώπη η Ελλάδα στις πατέντες, *Καθημερινή*, 4.4.2024 (D. Delevegos, Greece a laggard in Europe in terms of patents, *Kathimerini*, 4.4.2025)
[21] Ibid.

Related metrics on the European Innovation Scoreboard[22] are also favourable, with Greek researchers scoring 84.2 and 89.6 respectively for international scientific co-publications and most cited publications, which are at the median level for Moderate Innovator countries (the Moderate Innovator country category, in which Greece is included overall as well, is the third out of four country categories, the other three being [1] Innovation Leaders, [2] Strong Innovators and [4] Emerging Innovators, according to the European Innovation Scoreboard).

Intellectual capital generation of this sort is based on meaningful investment in higher education as well as academic research. Greece is just outside the top 30 countries worldwide in science and engineering graduates (it is 32nd to be exact), and came 26th out of a grand total of 132 countries in how many researchers it has per million of population, according to the Global Innovation Index 2023[23]. Expenditure on R&D is also growing, with Greece coming 6th in the EU rankings relative to GDP and 16th in the EU in absolute numbers, at 1.6 billion euros. Notably, between 2012 and 2022, Greece achieved the third highest jump in R&D expenditure in in the EU, rising from 0.39 % of GDP in 2012 to 0.76 % of GDP in 2022[24].

What explains this divergence between intellectual output and its utilisation for economic and/or public policy purposes? Simply this: almost all R&D funding in Greece originates from competitive EU grants, whether these be from Cohesion Funds or the European Research Council (ERC). Thus:

- There is no medium-term national funding for Greek research teams; however, a five-year period of funding is considered essential to enable the creation of breakthrough intellectual output with the promise of a substantial economic or societal upside.
- In turn, the lack of national funding means that research is not oriented towards domains in which Greek firms may also have a strategic focus, either due to sectoral maturity (e.g. pharmaceuticals) or national priorities (e.g. national defence).
- Since they are not funded out of the core budget of universities and research institutes, Greek research teams have to pursue one eligible EU grant after another in order to survive. Consequently, technology transfer to the economy and public policy is at best an afterthought, a side-line activity.
- Career advancement has been rigid and salary scales in Greek universities and research institutes had a strict ceiling until the very recent Pierrakakis higher education reform. As a result, many of the best-performing scientists are either leaving the country or cannot be enticed into returning.

Cumulatively and in interaction, these factors mean that Greek universities and research institutes neither produce nor evolve intellectual output (including, most prominently, IP) in anything like the quantity and quality that Greek firms and/or Greek public policy aims would require.

On the positive side, and commencing in 2011 with the assistance provided by EU (and, subsequently, European Investment Bank (EIB) Group) funding, there has been steady

[22] European Commission, *European Innovation Scoreboard*, 2022
[23] World Intellectual Property Organization, *Global Innovation Index 2023-Innovation in the face of uncertainty*, 2023
[24] Ch. Papalexatou and M. Matsaganis, In focus: Total government budget allocations in R&D in Greece and in the EU, *ELIAMEP*, 31.8.2023

accretion of know-how and resources directed at nurturing the founding in—and/or the attracting to—Greece of start-up firms with a high-tech orientation[25].

Out of the ten most highly-valued Greek start-ups, 2011- 2023, two have a substantial defence orientation.

In 2023, thirteen specialized VCs were operational in Greece, with seventy start-ups receiving total funding of 485 million euros. Of this funding, 33 % originated abroad, primarily the US, which serves as a vote of confidence in the promise of the Greek start-up scene. The totality of the value of Greek start-ups was estimated at 8.2 billion euros in 2023. Out of the ten most highly-valued Greek start-ups, 2011- 2023, two have a substantial defence orientation: namely, Hack the Box, a cyber security firm with four defence ministries as clients, and TileDB, a databases integrator which has also received an equity stake from Lockheed Martin Ventures.

The current Greek government has aggressively built on the efforts of its predecessors by legislating (i) a favourable stock options plan to accommodate this indispensable form of reward for start-up firms, (ii) a total tax exemption for firms' R&D costs, and (iii) a facilitative framework for the establishment of start-ups by university and research institute staff, including the establishment of technology transfer offices. Given the expertise accumulated by Greek VCs, all of which have received EIB Group stakes, in identifying and funding firms with a promising high-tech orientation, it is vitally important that the EIB acts upon the recommendation the EU Commission included in its recently issued European Defence industrial Strategy[26] to lift all restrictions in funding core defence firms. This would mean that Greek VCs would not be restricted from funding core defence technologies emanating from Greece's fast growing start-up community and small to medium-sized defence firms.

Taking stock of Greece's innovation system and relating it to the analysis in the previous section, it is clear that Greece is an outlier in terms of its status as a high-income country which has failed, overall, to systematize the alignment of substantial research funding with policy goals meant to improve either economic or state performance.

Greece is actually considerably less of a laggard than the current exemplar of defence-related innovation we examined above: Ukraine.

Suffice it to say that the US created the global benchmark for operationalizing the technology transfer process as far back as 1980, more than fifty years ago, through the Bayh & Dole Act of that year. Specifically, the Bayh & Dole Act permitted the commercialization of federally-funded innovation taking place in universities and research institutes. Since the passing of the Act, US state-funded universities and research institutes have operationalized the transfer of technology to private sector firms, thus laying the foundations for relentless innovation via VC-funded start-up creation. It is precisely this VC-start-up complex that is now pushing the US DoD and US Armed Forces to integrate its innovation output into their operations.

In contrast, the technology transfer process in Greek universities and research institutes was operationalized less than five years ago. It is illuminating that in the annual reports of ASTP, the pan-European association of technology transfer professionals, only one Greek public research organization, state university or state research institute provided data in 2020 (relating to the 2018 financial year), in contrast to 25 from Ireland and seven from Portugal (for the last year data were collected by ASTP, 2019)[27].

Nonetheless, despite Greece having less than five years of institutionalized technology transfer experience compared to the US's fifty, Greece is actually considerably less of a

[25] Foundation Innovation Reports, *Startups in Greece-Venture Financing Report 2023-2024*, 2023
[26] EU Commission, *European Defence Industrial Strategy*, 5.4.2024
[27] ASTP, *ASTP 2022 Annual Survey on the European Knowledge Transfer Landscape Financial Year 2020-Executive Data Report*, 2022.

laggard than the current exemplar of defence-related innovation we examined above: Ukraine. Specifically, according to the European Innovation Scoreboard, Ukraine came 39th out of 39 EU and non-EU European countries, with Greece coming 25th in this ranking and earning a place in the Moderate Innovator category, one above Ukraine's status as an Emergent Innovator country[28]. We can thus say that, relative to its smaller size, Greece has the resources in terms of human capital, research institutions and expertise in funding knowledge-based business ventures, to perform at least as well as Ukraine as an above average innovator in defence, assuming powerful enough incentives are in place.

The Greek Defence Technological Industrial Base (DTIB)

The Imia crisis led Greece to replenish its major weapon systems substantially at a time when other EU member countries were massively cutting down their Cold War force structures.

The strengths and weaknesses of Greece's extant DTIB are also a determinative factor in linking innovation up with the Greek Armed Forces.

The first factor we need to take into account when considering the Greek DTIB is the Imia crisis (1996), which brought Greece and Turkey to the brink of war and resulted in a major weapons acquisition spree in the late 1990's to early 2000's—a spree that was accompanied by offset agreements on the basis of which major weapon systems were manufactured in part in Greece. The Imia crisis led Greece to replenish its major weapon systems substantially at a time when other EU member countries were massively cutting down their Cold War force structures. Indicatively, Greek Armed Forces acquired US F16s and French Mirage 2000 fighter aircraft, German Leopard main battle tanks (MBTs—Greece currently has one of the largest Leopard tank fleets in Europe), T-214 submarines, and US Patriot air defence systems. Due to the off-set agreements put in place, these acquisitions meant that Greece's major defence companies, which were mostly but not exclusively owned by the state, were engaged to either manufacture these weapon systems in part and under license, to manufacture component parts for the global supply chains of the foreign manufacturers of the weapon systems acquired (in the case of Lockheed Martin's F16s), and/or to play a role in rolling out future upgrades to these weapons systems.

Indicative weapon systems procurement orders with Greek DTIB participation[29]

Weapon System	Greek DTIB off-set contribution	Agreed Date of Delivery
10 Mirage 20000 EG fighter jet upgrades (France)	Mirage 2000–5 Mk2 Configuration Upgrade	2007
3 T-214 submarines (Germany)	Assembly and Manufacturing in Greece	2006–2009
170 Leopard 2A5 MBTs (Germany)	Component parts manufacturing	2006–2009
20 NH90 helicopters (France, Germany, Italy)	Component parts manufacturing	No date provided
1100 Stinger MANPADS (US, from the European Stinger Production Programme)	Component parts manufacturing	1993–2004
Patriot Air Defence System US	Component Parts	2002–2004

[28] European Commission, *European Innovation Scoreboard*, 2022
[29] Information derived from Π. Βλάχου, Αμυντική Βιομηχανία, 222 Κλαδική Μελέτη, Μονάδα Κλαδικών Μελετών, *IOBE*, Μάρτιος 2009, [P. Vlahou, Defence Industry, Sectoral Study 222, Sectoral Study Unit, *IOVE*, March 2009].

30 F16 Block Fighter Jets USA	Follow-on Support	No date provided

Greek defence companies have engaged, as subcontractors, with highly advanced weapon systems of mixed US and European provenance.

As indicated by the weapon systems listed above, Greece has bought quality and has spread its bets in doing so. From the point of view of Greece's DTIB, these factors have meant that Greek defence companies have engaged, as subcontractors, with highly advanced weapon systems of mixed US and European provenance.

Poor governance, trade union capture leading to excessive personnel costs, a political leadership whose focus on nominal rather than real military strength led to the underfunding of follow-on support and upgrades, and no state spending on defence R&D (in good or bad times for the state's fiscal capacity), undermined Greek defence firms' ability to use offsets as a launch-pad for developing an exports portfolio. Consequently, when Greece's fiscal crisis broke out, the state-owned defence sector came in for ruthless cost cutting, with Greece's creditors pressing for its near total elimination.

Nonetheless Greece's DTIB is still standing in our post-crisis era. The strengths which got the DTIB through the fiscal crisis are: a) its portfolio of partnerships with leading foreign defence contractors, b) a capital base of facilities and equipment, along with valuable licenses for weapons manufacturing and testing, which means that the industry faces no major NIMBY obstacles as it pursues expansion, and c) an experienced workforce, despite its partial depletion during the fiscal crisis.

To these legacy strengths we must add benefits that have accrued as a result of the post-fiscal-crisis environment. Two out of Greece's five financially troubled defence companies, namely the Skaramanga and Elefsina shipyards, have been put on a sound financial footing through privatizations, while EAV, the state-owned aerospace company, has been recapitalized through state support.

The current Greek government has recommitted to the policy mix of the post-Imia procurement wave, which is to say (a) acquiring high-end weapon systems while (b) cementing optionality in external security provision by procuring weapon systems from more than one external security provider.

With the US, that has meant the transition of a major part of the F16 fleet to the Viper configuration plus an expression of interest in acquiring the F35, with EAV implementing the former agreement and expected to play a yet-to-be-determined role in the latter.

With France, the policy mix has entailed the acquisition of Rafale fighter jets and Belharra frigates. In the case of the latter, Greek DTIB involvement is being instigated post-acquisition, primarily through medium-sized Greek firms entering agreements with the manufacturer of the Belharras, the Naval Group.

Recently, the MND has declared an interest in participating, with Greek shipyards, as an industrial partner in the manufacture of the US Constellation class frigates, a design adapted from the Italian Fincantieri-produced FREMM frigates.

In land systems, there was initially a good deal of 'noise' around the upgrade of the Leopard MBT fleet, which would involve a partnership between its German manufacturers, Rheinmetall and Krauss-Maffei, and one of the Greek state-owned companies and possibly one or more of the private ones, along with the potential

acquisition of the last-generation Lynx infantry fighting vehicle (IFV). While the current intentions of the MND remain unclear, the emergence of armour vulnerabilities during the ongoing Russo-Ukrainian war will sooner or later, in our estimation, put the issue of the modernization of Greek armour units in the spotlight.

Greece's existing DTIB has two more major drivers, which involve partnerships with mostly US and European firms.

First, there is the issue of Follow On Support, which was massively neglected during the years of fiscal crisis, affecting both availability ratios and the critical modernization of weapon systems, with land, air and naval fleets all being cannibalized for component parts. A decisive reversal of this practice, which has been reaffirmed by the present civilian leadership of the MND, will enhance the technological sophistication of the Greek TDIB still further.

Selected Hellenic Armed Forces military systems in need of Follow On Support and/or upgrades

Military System	Manufacturer
C-27J Spartan transport airplane	Alenia Aeronautica, Leonardo, Alenia Aermacchi, Lockheed Martin
Leopard MBT	Rheinmetall, Krauss Maffei
MEKO Frigates	Blohm + Voss
NH90 AS332 utility military helicopter	Airbus Helicopters, Leonardo, Fokker Aerostructures

Source: Various reports in Greece's specialist defence press

The second driver is the Greek DTIB's sizeable role in the replenishment of European armouries mandated by the EU's Strategic Compass. Indicative of the possibilities here is the participation of a Greek company, EODH, a Krauss Maffei subcontractor, in the manufacturing of armour for Leopard tanks ordered by Norway following the break out of the Russo-Ukrainian war[30]. EODH owes its existence to the offset agreement generated by the past acquisition mentioned above of Leopard MBTs by the Hellenic Army. According to press reports, the state-owned Hellenic Defence Systems will also be a beneficiary of the EU's ASAP programme to replenish inventories of 155 mm artillery shells, having submitted a joint proposal with GSK, a Czech firm[31]. Inevitably, participation of the Greek DTIB in the massive effort to replenish European armouries will be affected by the ability of its individual firms to overcome legacy constraints, with the need to reassemble a skilled workforce posing the greatest challenge of all. That being said, rising sales volumes of even non-innovative defence articles obviously generate opportunities and the financial resources required to enter more innovative lines of work.

Obviously, EU-wide developments will be critical, and here Greece will be a regime-taker not a regime-shaper. Thus, the extent to which key EU member countries such as Germany and France, and secondarily Italy and Spain, take a decisive step towards a consolidated European DTIB, backing up a 'geopolitical Europe' fiscally and via corporate consolidation, is the extent to which Greece will follow suit.

In that scenario, the Greek DTIB would gradually transition those of its current European industrial partnerships that are mostly bilateral into those pan-European consortia that would come to develop the common European fighter aircraft, frigate, MBT and so on.

[30] See, https://defea.gr/major-partnership-agreements-at-defea-2023/

[31] Σ. Ιωαννίδης, Παράθυρο ευκαιρίας από Βρυξέλλες για ΕΑΣ, *Καθημερινή*, 6.4.2024 [S. Ioannidis, Window of Opportunity from Brussels for EAS, *Kathimerini*, 6.4.2024].

After all, the major French, German and Italian defence companies that have partnered with Greece bilaterally, will be core pillars, in one way or another, of any future pan-European consortia that undertake the production of these platforms.

…to the extent that we have catalytic developments in the consolidation of the pan-European DTIB, we may yet see Greece's DTIB transition to a different, innovation-intensive business model.

To the procurement-led portfolio of the Greek DTIB partnerships we should add the R&D portfolio amassed by Greek defence companies via EDF and PESCO as a second point of entry to a future European DTIB. Sixty Greek entities currently participate in thirty EDF-funded partnerships, which puts Greece is fifth place in the EDF EU-country rankings on the basis of participations. Altogether, its participations in EDF and PESCO put Greece in the top five EU member countries—the first four being France, Italy, Spain and Germany[32].

Thus, and to the extent that we have catalytic developments in the consolidation of the pan-European DTIB, we may yet see Greece's DTIB transition to a different, innovation-intensive business model. Thus, Greek defence firms may move on from part-manufacturing for mature technologies via offset agreements to participating in various pan-European innovative defence systems from beginning to end, from R&D through to production, follow-on support and upgrades. That this model will also incorporate partnerships between the core large and medium-sized defence firms which are long-established or even founding members of the Greek DTIB and newer, smaller Greek start-ups active in such domains as space and AI, has been clearly communicated by the new leadership of EAV, the state-owned aerospace firm[33].

This bifurcation point must be placed in the larger, post-economic-crisis context of Greece's business model, in which it is the policy consensus that the Greek state must fund R&D from national sources to enable the Greek business community to migrate to higher-value-added activities[34]. As mentioned in the previous section, the Greek government has not bitten the bullet yet, with the Greek R&D ecosystem still being funded primarily by ERC and EU Cohesion Funds.

When we put all the pieces together, however, we see that Greece's DTIB is a positive outlier, among other Greek manufacturing and/or service sectors, in terms of its ability and propensity to innovate. This is obviously due to the very nature of war as a driver of technological innovation and progress, manifested in the case of the Greek DTIB in companies that either have a core defence orientation or have entered the defence realm by leveraging their technical excellence in the context of an overall high-tech mission.

Among the core defence firms, the sector's technological depth is indicated by the acquisition of Intracom Defence by the leading Israeli defence firm, Israel Aerospace Industries. Intracom Defence, a leading Greek private sector defence firm, is one of the companies that grew in technological sophistication on the back of the post-Imia acquisition spree and the partnerships it enabled with leading prime defence contractors abroad.

In the non-core defence firm universe, just as we have notable entries among the most successful Greek start-ups that engage, albeit not exclusively, in defence work (the above-mentioned Hack the Box and TileDB), so we find similar cases of larger and longer-

[32]See, S. Blavoukos, P. Politis-Lambrou and T. Delatolas, Mapping EU Defence Collaboration One year on from the Versailles Declaration, *ELIAMEP*, Policy Paper 133, 20.5.2023.

[33] See, Β. Νέδος, Αλέξανδρος Διακόπουλος, πρόεδρος και διευθύνων σύμβουλος της Ελληνικής Αεροπορικής Βιομηχανίας - Να μην στηρίζεται η Άμυνα στην καλοσύνη των ξένων, *Καθημερινή*, 11.2.2024 [V. Nedos, Alexandros Diakopoulos, President and Managing Director of the Hellenic Aerospace Company – Defence should not rely on the kindness of strangers, *Kathimerini*, 11.2.2024].

[34] This consensus has been encapsulated most prominently in a government-commissioned report led by Greek-Cypriot Economics Nobel Prize winner, Professor Christopher Pissarides, see https://www.lse.ac.uk/finance/news/2020/Dimitri-Vayanos-Presents-Growth-Plan

established firms pursuing defence-related work. This should come as no surprise. Precisely because defence is the realm par excellence that makes use of high-tech technologies, we would expect high-tech firms that have not had an original or exclusive defence orientation to gravitate towards defence, given the organic opportunities to leverage their high-tech expertise. We note three such Greek firms here: namely, Raycap, founded by the most highly-admired Greek high-tech industrialist, the late Kostas Apostolides; BETA-CAE, an international leader in developing simulation systems, which was acquired by US-based Cadence for 1.24 billion USD; and Sunlight, a European leader in electric battery manufacturing.

Greek DTIB firms were compelled by the crisis to become more extrovert, acquiring technically-demanding ministries of defence and armed forces as clients.

So, considering the notable examples just mentioned, the Greek DTIB has clearly long been exposed to working with some of the most R&D-intensive US and European defence firms. Second, Greek DTIB firms were compelled by the crisis to become more extrovert, acquiring technically-demanding ministries of defence and armed forces as clients. Third, due to the lack of national research funding, these firms engaged in comprehensive scoping of emerging defence capabilities through their participation in the above-mentioned EU defence R&D programmes. Fourth, due to the renewed MND acquisitions programme, Greek DTIB firms are being exposed to the needs of some of the most advanced weapon-platforms worldwide. Fifth, the MND's commitment to follow-on support means that DTIB firms will increasingly gain insights into, and contribute input to, highly advanced upgrades to a variety of weapon systems. Sixth, the Greek DTIB will be a party to the government's determination to abandon its 'off the shelf' policy and participate in the development of next-generation weapon systems from conception through to manufacturing. Seventh, due to the return of 'Big War' and the emerging secular trend in rising defence expenditures, Greek DTIB firms have been presented with a once-in-a-lifetime opportunity to increase their exports while concomitantly participating in the innovation wave catalysed by the Russo-Ukrainian war.

…as a latent component of the Greek DTIB, we should mention the early retirement of senior Armed Officers from all Services due to the 'up or out' promotion system.

Last but not least, and as a latent component of the Greek DTIB, we should mention the early retirement of senior Armed Officers from all Services due to the 'up or out' promotion system. Historically, such officers—many of whom have received a demanding technical education and training and have either operated or supported highly sophisticated weapon platforms and munitions—may have supported the Greek DTIB and foreign prime contractors in a primarily marketing role, helping to open doors at the MND and advance sales of weapon systems. To the extent that the Greek DTIB does take an innovative turn, we can assume that this pool of retired officers will provide much of the thinking and know-how on which this turn will be based.

The client: The Ministry of National Defence and the Greek Armed Forces

The MND and the Greek Armed Forces are, of course, constitutive of the defence-related innovation that will be produced. Strengths and weaknesses originating in civilian & military interactions will have a determinative influence on the degree to which innovation will be generated and the impact such innovation will have on the battlefield efficiency of the Greek Armed Forces.

We must first mention the recurrence of grey-zone competition between, in the main, the rival Navies and Air Forces of Greece and Turkey. This means that the Hellenic Navy (HN) and Hellenic Air Force (HAF) have extensive experience in complex and demanding operations, which certainly creates insights among HN and HAF personnel into the kind of

operational challenges that can be met with the help of advanced technological solutions. That being said, the Hellenic Army (HA) has no such exposure and does not have the opportunity to gain relevant experience in the context of grey-zone operations[35].

The HA is also operating under the burden of an underperforming conscription service; the present leadership at the MND has admitted this and is seeking to reform it. This has meant that large-scale HA exercises are substantially scripted, and conscripts are not in a position to operate new technologies critical to the battlefield. For example, under the current rudimentary conscript training regime, it is simply unrealistic to deploy at scale either FPV drone systems or information systems that allow the soldier in the field to both receive and send actionable battlefield information[36]. However, both these practices have become routine, as well as dynamically evolving and innovation-inducing, as discussed above, for the Ukrainian Army, which is predominantly manned by non-professionals. The fact that HA is not involved in grey-zone operations has also meant that it has not engaged in any extensive modernization of its equipment during the latest round of major acquisitions programmes initiated after the end of the fiscal crisis; indicatively, its fleet of Leopard MBTs has not been upgraded and no new infantry fighting vehicles have been procured. Needless to say, this sort of operational and technological stagnation is not conducive to innovation.

…neither combat nor the imperative of force protection has been a motive to introduce, let alone innovate, new technologies, as it has been with other Armed Forces.

The prioritization of grey-zone operations and HAF and HN procurement needs by the civilian leadership was underpinned—at least prior to the break out of the Russo-Ukrainian war—by the assumption that Greece did not need to prepare for a 'Big War' scenario with Turkey. Such an eventuality was ruled out, due to the near certainty of a US intervention motivated by the need to preserve the integrity of NATO. This assumption has permeated key facets of the Greek Armed Forces, and had negative implications for the innovation propensity of the Greek Armed Forces.

Coupled with the technological and operational stagnation of the HA, the ruling out of the 'Big War' scenario has contributed to the retention of a retrograde command structure based on an all-powerful Chief of the Hellenic Defence General Staff, the lack of separate joint command headquarters, to the Hellenic National Defence General Staff, and hence the under-development of joint warfare command and control capabilities. It has also fed into the underfunding of training and operations and the lack of lifecycle Follow On Support mentioned above, with the Greek Armed Forces demonstrating nominal force structures since weapon platforms have not been upgraded and the availabilities and technologies of key weapon systems have degraded and become redundant over time[37].

Another major minus is Greece's outlier status within NATO in terms of the Greek Armed Forces' participations in multilateral operations that involve actual combat[38]. Not least due to the deligitimisation of NATO in Greek public opinion after the invasion of Cyprus by Turkey in 1974, Greece's civilian leadership has studiously avoided putting Greek Armed Forces personnel in harm's way. Consequently, neither combat nor the imperative of force protection has been a motive to introduce, let alone innovate, new technologies, as it has been with other Armed Forces. We could do no worse than mention in this context: (a)

[35] The author examines this issue in Beating the authoritarian legacy: upgrading conscription in Greece and Taiwan, *War on the Rocks*, 7.9.2022
[36] For an analysis of the state of the Greek conscription system, see A. Kamaras and N. Stournaras, Achieving qualitative superiority: Greek conscription and the Turkish threat, *ELIAMEP*, Policy Paper 93, 4.4.2022
[37] The author examines the shaping influences of the suboptimal organizational structure of the Greek Armed Forces in: Joint Operations of the Greek Armed Forces: Much to be desired, much to be achieved, *ELIAMEP*, Policy Paper 151, 1.6.2023, and the nominal versus substantive Armed Forces issue in: The Greek Defence Sector: Turning the page?, *ELIAMEP,* Policy Paper 126, 9.2.2023
[38] See, Antonis Kamaras, Joint Operations of the Greek Armed Forces: Much to be desired, much to be achieved, *ELIAMEP*, Policy Paper 151, 1.6.2023

how the participation of Italy and Sweden in Afghanistan, and in Sweden's case in Mali too, accelerated the employment of drone operations in these two countries Armed Forces; and (b) how Turkey's operations, either by itself or through proxies, on multiple battlefields spurred on the development of both its DTIB's drone programme and the integration of drones into its combined and joint operations[39]. Additionally, particularly in democracies, which as we noted accrete time-consuming compliance mechanisms, a nation's Armed Forces and its DTIB are allowed to interact with much greater speed under the exigencies of combat operations, thus accelerating either the introduction of innovative technologies or innovation itself. As Trevor Taylor, Director of the Defence, Industries & Society Program at the Royal United Services Institute, noted in a meeting in which the author also participated:

"Once the UK Prime Minister decided on military action against Libya in 2011, without a contract in place, BAE Systems personnel worked alongside RAF technicians over a weekend to modify Typhoon aircraft to be able to operate effectively in the Libyan threat environment, an example of the benefits of the advantage of being able to modify as well as sustain equipment in the national inventory."

Importantly, the initiative taken by the current leadership of the MND to allow the HN to participate with a frigate in the EU ASPIDES mission, which involves being exposed to anti-ship missile and drone attacks launched by Houthi rebels in Yemen, definitely signals a shift in the civilian leadership's appetite to accept risk for the personnel of the Armed Forces. It is also illuminating that this participation has revealed just how far behind the HN now is in terms of defending itself against air threats and providing area defence. This has underlined the need to upgrade the aging MEKO frigates of the HN, over and above the procurement of three of the latest-generation French Belharra frigates[40].

Two additional constraints relate to money: how much there is, and the extend to which the MND is trusted to spend it. Simply put, defence allocations, and trust in how they are managed, are both in short supply in Greece.

Indeed, Greece is one of the highest spenders on defence relative to its GDP in NATO, but the problem is that it is also one of the poorest countries in the EU-27, and still more so after the fiscal crisis. Sweden, which has nearly the same population size as Greece, spends much less than Greece relative to its GDP (1.5 % in 2023 as opposed to Greece's 3.2 % in the same year), but spends more in absolute numbers ($ 8.8 billion compared with Greece's $ 7.7 billion in the same year), because it is a much wealthier country[41]. Indeed, Sweden spends more than Greece on defense despite the fact that: (a) Finland, with which it shares a 614 km border, stands between Sweden and the Russian Federation; and (b) Finland, with its 1,340 km border with the Russian Federation, is not just a geographical buffer but also a military one, as it possesses one the most robust and well-funded territorial defence systems worldwide, which received $ 7.3 billion in 2023, which is nearly as much as Greece's entire national defence spending (Finland has just under half the population of Greece)[42]. Importantly, even prior to their joining NATO, Sweden and Finland were well-integrated into Europe's collective defense, underpinned by US military might. This does not hold for Greece, which, as the only NATO member to be threatened by another NATO member, is to all intents and purposes not covered by Article 5 of NATO.

[39] The author treats this issue extensively in: Turkish drones, Greek challenges, *ELIAMEP*, Policy Paper 57, March 2021
[40] Α. Φωτάκη, Ελληνική Αποστολή στην Ερυθρά Θάλασσα, *Τα Νέα*, 22.12.2023 [A. Fotaki, Greek Mission in the Red Sea, *Ta Nea*, 22.12.2023]
[41] N. Tian, D.L. Da Silva, X. Liang and L. Scarazzato, Trends in world military expenditure-2023, *SIPRI Fact Sheet,* April 2024.
[42] Karl Dewey, Finland and Sweden bolster the West's defence topline, *Institute for International and Strategic Studies*, 9.10.2023

Greece's fiscal constraints impacted on weapon systems maintenance and modernisation, as mentioned above, but they also led to very small operations and training budget allocations,[43] which inevitably affect its Armed Forces' ability to try and test innovations in a simulated war environment.

Another factor which impacts negatively on innovation capacity is the very low pay of Armed Forces personnel. As it is not politically feasible for Armed Forces personnel to be outliers in a state system which underpays similarly highly-educated and trained functionaries, such as intensive care unit doctors and nurses in the national health system[44], the MND has difficulty retaining the kind of highly-educated and -trained personnel that innovation is based upon[45]. In turn, the low compensation of highly-skilled personnel is baked into Greece's political economy, due to the state employees' trade unions preferring to represent the interests of the majority of its low-skilled members[46].

…the capacity of the Armed Forces to retain a critical mass of professional officers and other ranks who are highly skilled technically, which is a sine qua non for innovation integration, is at risk.

The negative implications of such fiscal constraints, whatever their origin, for co-creating innovation are obvious. The Greek Armed Forces simply do not train and operate at a tempo and with the critical mass of equipment that could allow for innovation to be adequately informed by such training and operations, and to evolve further through feedback loops with training and operations. Moreover, the capacity of the Armed Forces to retain a critical mass of professional officers and other ranks who are highly skilled technically, which is a sine qua non for innovation integration, is at risk.

On the trust issue, we note that Greece has the lowest ranking (D) in terms of transparency in its national defence system.[47] In addition, it has suffered an extensive defence scandal in weapons procurement in the past, which resulted in jail sentences for two MND Ministers and the legitimacy of one of Greece's major ruling parties being undermined[48]. This scandal resulted in a legislative overreaction which has left procurement overly rigid, with major weapon systems procurements requiring legislative acts, and, understandably, the officers responsible for procurement being leery of being exposed to legal jeopardy. The issue of trust is highly pertinent to innovation, due to its high failure rate as much as the highly subjective nature of its evaluation in a country like Greece, which has historically procured weapon systems from abroad. These weapon systems are either mature in their development and widely recognized as being the best-of-breed internationally, and/or are designed and manufactured by leading international defence firms and were first procured by the Armed Forces of the countries where these defence firms are based.

The issue of trust is highly pertinent to innovation.

Greece is not in a position to implement the sort of civil-military fusion that is available to an authoritarian regime like that led by President Erdoğan in Turkey, nor should it seek to do so. In Turkey's case, the most prominent example of such fusion would be the development of the Bayraktar family of drones; significantly, the son of the company's

[43] Indicatively, doubts have been expressed about the HA's ability to adopt the Finnish template on conscription, which includes extended field exercises, due to the limited operations and training budget; the Minister of National Defence has stated that this is the government's intention. See, Σ. Βλάσσης, Το 'Φινλανδικό' μοντέλο συγκρίσεις για θητεία και εφεδρεία, *Δούρειος Ίππος*, 26.2.2024 [S. Vlassis, The 'Finland' model and comparisons for conscription and reserves, *Doureios Ippos*, 26.2.2024].

[44] See, Π. Μπουλουτζα, Κλίνες υπάρχουν, αλλά όχι πάντα προσωπικό, *Καθημερινή*, 28.1.2024 [P. Bouloutza, There are beds but not always personnel, *Kathimerini*, 28.1.2024].

[45] There has been extensive as well as well-documented commentary on the inability of the HN in particular to hold on to its officers, given the low levels of compensation, see indicatively, Π. Λασκαρίδης, Άμεση ενίσχυση του Πολεμικού Ναυτικού, *Καθημερινή*, 27.11.2022, and N. Κατσίμπρας, Είκοσι χρόνια στη θάλασσα, χωρίς προοπτική, *Καθημερινή,* 28.1.2024 [P. Laskaridis, Immediate support for the Hellenic Navy, *Kathimerini*, 27.11.2022 and N. Katsimbras, Twenty years at sea without prospects, *Kathimerini*, 28.1.2024].

[46] For the drivers of resistance to public sector remuneration reform see, D. Katsikas, Crisis, clientelism and institutional resilience: reflections on a public sector reform under MoU's, *Hellenic Observatory-LSE*, Paper No 176, October 2022.

[47] See, Government Defence Integrity Index, Country Brief: Greece, *Transparency International – Defence & Security*, 2024

[48] See, indicatively, X. L. Liang, Greek Land Forces and German Bribery, *World Peace Foundation-Tufts University / Fletcher*, 4.4.2019

owner is also the husband of one of the President's daughters[49]. As we will see below, however, Greece has the means to generate the type of trust-based civil-military fusion, which is compatible with its status as a well-consolidated democracy.

What can be done and what should be done?

At the outset, we need to say that the ingredients are in place for Greece's innovation ecosystem to make a meaningful contribution to the battlefield effectiveness of the Greek Armed Forces. The other side of the coin is that the MND and Greek Armed Forces can serve as a catalyst for a commensurate boost in the capacity of the country's innovation ecosystem to generate high-tech technologies for which there is sufficient domestic and international demand. The institutional ownership of innovation is in place at the MND, both in the civilian and the military leadership and there is both a highly technical workforce of officers and other ranks willing to embrace and contribute to the generation of innovation, and a private sector and academic community with the reservoir of technical and scientific knowhow necessary to co-create it.

At the outset, we need to say that the ingredients are in place for Greece's innovation ecosystem to make a meaningful contribution to the battlefield effectiveness of the Greek Armed Forces.

We can point to both positive and negative cases in our very recent past, when the presence or absence of these ingredients generated innovation or failed to generate innovation, respectively, in Greece.

In the positive case, the containment of the pandemic, the existential threat, acquired institutional ownership at the Ministry of Digital Governance (MDG), which was also gifted one of the most technologically- and scientifically-capable workforces in the Greek state sector, the personnel of the General Secretariat of Information Systems, along with a supporting cast of private sector firms in the IT sector. The outcome was the rollout of a comprehensive set of tools which accelerated the digitisation of the Greek state and thus limited personal interactions, rendering the vaccine campaign effective.

In the negative case, despite the personal commitment of the Prime Minister and representations to him by a globally distinguished team of diaspora scientists and pharma executives including Albert Bourla, the CEO of Pfizer, and Stelios Papadopoulos, then President of Biogen,[50] the proposal to invest in Greece developing an innovative biomedical sector through breakthrough R&D seems to have fallen by the wayside. Two years later after this proposal was put on the table, a member of this highly distinguished advisory body, Spyros Artavanis-Tsakonas, Professor Emeritus of Harvard University and President of ESETEK, the government's research advisory body, lamented the lack of a national research strategy in Greece[51]. The proposal addressed a long-term strategic goal rather than an urgent need, and the Ministries of Health and National Development obviously lacked the sense of mission induced by the pandemic at the MDG and by the rising Turkish threat at the MND. Nor, seemingly, was it embraced by a pharmaceutical sector of mixed Greek and foreign ownership, possibly because the Greek pharmaceutical firms rely on the manufacturing of generics and the multinational pharmaceutical firms with operations in Greece have located their R&D centres to countries with a long tradition of pharma research excellence, such as the UK and Switzerland.

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[49] The author reviews the issue of the massive conflicts of interest which permeate the Turkish defence sector in: The Greek Defence Sector: Turning the page?, *ELIAMEP*, Policy Paper 126, 9.2.2023.

[50] Σύσκεψη στο Μαξίμου για προσέλκυση επενδύσεων στην βιοτεχνολογία, Capital.*gr*, 19.5.2022 [Conference at the Maximos Mansion to attract investments in biotechnology, *Capital.gr*, 19.5.2022]

[51] Σ. Αρταβάνης-Τσάκωνας, Για ένα ενιαίο χώρο έρευνας και τριτοβάθμιας εκπαίδευσης, *Καθημερινή*, 28.1.2024 [S. Artavanis-Tsakonas, For a unified research space in higher education, *Kathimerini,* 28.1.2024.

As per the literature, the decisive factor in such a mutually reinforcing outcome, being an innovative DTIB and innovative Armed Forces, is political will underpinned by a wider societal consensus based on the understanding that Greece does indeed need to field battlefield-effective Armed Forces. Such Armed Forces would be capable of deterring Turkey from challenging the country's sovereign rights militarily, or even threatening its territorial integrity. Should this deterrence fail, the Greek Armed Forces would be able to hold their own in a 'Big War' scenario with Turkey[52].

By lifting what is widely perceived at both the elite and public level in Greece as a ceiling of Turkish aggression towards Greece, the current geopolitical juncture could indeed provide the impetus required to introduce innovation into the Greek Armed Forces. In effect, a shift in the country's strategic and military cultures would be brought about which privileges the abandonment of nominal military strength, with pockets of actual military strength, and the adoption of the 'all hands on deck' attitude that is required for the Greek Armed Forces to serve the imperative of deterrence against a 'Big War' scenario. It is worth noting, at this point, that Greece is not the exception but rather the rule in a European continent confronting the security implications of a 1930s-style isolationist America encapsulated in the prospect of a Trump victory in the US Presidential elections this November[53].

Such a shift can provide the underpinnings for an innovation strategy which, as befitting a small to medium sized state with scarce resources at its disposal[54], enhances the capabilities of the existing Armed Forces, which are additionally rendered ready and able—through maintenance, training and Follow On Support for its existing equipment and formations—to make use of such innovation. Furthermore, this innovation strategy is aligned with and serves a concept of operations designed to deter Turkey by addressing the Turkish Armed Forces' strengths and exploiting their weaknesses.

Assuming the political will and societal backing are present, what should we then be looking for, or suggesting, in order to render the Government's strategy for delivering innovation to the nation's Armed Forces credible and efficient? We have chosen ten factors:

1. Fiscal allocations sufficient to cover the ongoing modernization of the Armed Forces' training regimes, and thus the testing and evolving of innovative technologies and their integration into the Armed Forces' operations.
2. Aggressive use of the technical and scientific know-how inhering in the conscript pool, both by enabling male conscripts to serve, adequately compensated, for several years beyond their service and by introducing a selective draft for women with such know-how. Both men and women conscripts could thus be employed by the Hellenic Centre for Defence Innovation (HCDI), the organization that will lead the effort to introduce home-grown innovation into Greece's Armed Forces. Considering the well-documented scarcity of IT personnel in Greece[55], the MND has a unique opportunity to utilize conscription to source specialized personnel, even at modest levels of compensation, if it is in a position to offer them a highly

[52] For an examination of the drivers of defence innovation, particularly in peacetime, see S.R. Soare and F. Pothier, Leading edge: key drivers of defence innovation and the future of operational advantage, *The International Institute for Strategic Studies*, November 2021.
[53] See, typically, M. Hastings, Europe isn't prepared for an Isolationist America, *Bloomberg,* 21.1.2024.
[54] For the choices available to small to medium sized countries' Armed Forces in the pursuit of innovation, see M. Claessson and Z. Carlander, Are New and Emerging Technologies game-changers for smaller powers? *War on the Rocks*, 9.12.2021
[55] According to a survey, the demand for IT specialists in Greece exceeds the supply (15,000-16,000 per annum, producing a grand total of 120,000-140,000 in 2023-2030, see Deloitte-SEPE (Federation of Hellenic Information Technology and Communications Enterprises, *Study on the sufficiency of ICT specialists in the Greek labour market*, December 2022

creative and demanding work environment. As per the Israeli template, an added benefit of such a policy would be the supply of the Greek DTIB with a highly competent and inventive cohort of young technologists, once they leave the HCDI.[56]Importantly, the MND's legislation, in the final version passed into law, made provisions just for that type of participation of conscripts at HCDI.

3. Sufficient fiscal allocations invested in innovation, and primarily in IT-driven innovation. While this does not show up in nominal force structure comparisons with the Turkish Armed Forces, it meaningfully enhances Greece's deterrence against Turkish militarism, nonetheless.
4. Fiscal allocations sufficient to allow the Armed Forces, through adequate compensation, to retain an increasingly technically sophisticated personnel composed of professional officers and other ranks.
5. The introduction of demanding, non-scripted training for mixed professional-conscript formations in the HA, enabling these HA formations to test and utilize innovative technologies ranging from combined operations involving drones to electronic warfare missions, open source intelligence analysis, and so on.
6. The participation of Greek Armed Forces contingents composed of professionals in various multilateral or bilateral missions involving the potential of combat, the more the better. This involvement will inevitably result, at some point in time, in casualties of Greek Armed Forces personnel; however, participations in combat are necessary to speed up the innovation cycle of the Greek Armed Forces. In terms of incentivising the generation of innovation and creating an informed cohort of pro-innovation professional officers and other ranks, there simply is no replacement for combat. Suffice it to reiterate here that, in partnership with Turkey's DTIB, the Turkish Armed Forces (primarily, the Turkish Land Army) have acquired a qualitative edge as in the case of designing and executing combined operations involving UAVs and artillery, precisely because the political will exists to put them in harm's way, at the cost of casualties suffered in several battlefields. Casualties are accepted by the HAF as the inevitable cost of training and operations at the edge required for HAF to evolve its air superiority skills over its Turkish counterpart;[57] In particular, 165 HAF pilots have lost their lives in the line of duty from 1974 to today[58]. Now the civilian leadership must extend this ethos, and accept the painful price in casualties it entails, by enabling HA and HN participation in missions that carry the risks attendant to combat.
7. Meritocratic and stable officer promotion processes that would secure pro-innovation leaderships for the Greek Armed Forces at all levels, which would be able to judiciously guide the innovation process in the Armed Forces.
8. Modernization of the Armed Forces structure, particularly with the view to promoting joint operations and neutralizing innovation-hostile fiefdoms and single-Service parochial interests[59].
9. Trust in the integrity of procurement decisions, particularly those relating to innovation, which can be established by appointing individuals of the highest integrity and distinction, who enjoy cross-party legitimacy, to the governing bodies of MND's HCDI. Such appointments should include leading technologists from the diaspora who enjoy de facto independence from the country's political

[56] See, S. Sulman, Unit 81: The elite military unit that caused a big bang in the Israeli tech scene, *CTech*, 8.1.2021

[57] For and articulation of this HAF ethos see, Αντιπτέραρχος (Ι) ε.α.., Ε. Γεωργούσης, Καθήκον χωρίς όρια, *Ένωση Απόστρατων Αξιωματικών Αεροπορίας*, 4.2.2023 [Air Marshal (I) (retd) E. Georgousis, Duty without limits, *Union of Retired Air Force Officers*, 4.2.2023]

[58] Παρουσία ΥΕΘΑ Ν.Δένδια στις εκδηλώσεις τιμής και μνήμης για τον Σμηναγό (Ι) Κωνσταντίνο Ηλιάκη, στην Κάρπαθο, ΥΕΘΑ, 23 Μαϊου, 2024 (Participation of the Minister of National Defense, N.Dendias in the ceremonies to honor and memorialise Squadron Leader Constantinos Iliakis at Karpathos, MND, 23 May 2024).

[59]See A. Kamaras, 'Joint Operations in the Greek Armed Forces: much to be desired, much to be achieved', 11 January 2024, ELIAM EP Policy Paper 151.

system. Trust can also be imported in innovation-relevant procurement decisions, through partnerships, whether these be with Greece's European partners as with France, with which we are and will be sharing highly advanced weapon platforms in need of innovative add-ons (like the introduction of counter measures to unmanned sea vehicles in the case of the Belharra frigates) or with the US[60]. With such trust in place, the HCDI will be politically and organizationally able, in partnership with the leadership of the Greek Armed Forces, to rapidly finalise requirements, subsequently validate innovative product or service bids, and make the necessary resources available for their deployment at scale.

10. Collapsing inter-ministerial silos. This is particularly pertinent in the case of the MND's cooperation with the MDG for the utilization of jointly useful capacities ranging from low-orbit satellites, the processing of meteorological data, the utilization of public policy-created geolocation apps by the Armed Forces, and so on.

Under such conditions, the country's innovation ecosystem will acquire, for the first time ever, an innovation-prone client which can provide tangible as well as technically challenging targets along with funding over time to pursue these targets. Thus research teams in either the country's universities and research institutes or its defence firms, or more likely joint teams comprised of both academic and corporate researchers, will be able to engage in medium to long term purposeful research and development activities. Simply put, the MND will be able to offer the Greek research community an alternative to ERC and Cohesion funding which is more conducive to the production of innovation relevant to Greece's public policy and developmental goals.

Greece's DTIB will also be incentivized to invest in its R&D capacity, utilize its extensive participations in the various EU and NATO schemes to enhance its innovation, and not as a form of operational subsidy in disguise, and draw more extensively on the reservoir of talent inhering in the retired officers and other ranks of the Greek Armed Forces. To Greece's DTIB we can add those IT firms—whether they be start-ups, more mature IT companies under Greek shareholder control, or subsidiaries of IT multinationals—whose business has grown due to the government's digitization programme, which was mostly financed through the EU's Resiliency and Recovery Fund.

The country's community of VCs and start-ups would also be able to leverage their accumulated expertise and networks. Established start-ups with a credible international track-record in defence or dual use technologies would have a fighting chance of supplying their services to the MND. The Greek VCs which have grown their business through equity stakes in start-ups established by Greek founders abroad will have another arrow in their quiver in their efforts to attract R&D activities from start-ups domiciled in other jurisdictions in Greece, due to the emergence of a promising, defence-related ecosystem. In other words, start-ups would not only have an opportunity to source a talented work force in Greece, but also to acquire a client—the MND—which can provide both additional revenue streams and opportunities to evolve their innovative products and services in a way that is relevant to their international sales strategies. As mentioned above, a prior condition for the fulfilment of this promise would be that the EIB, which is the most important funder of Greek VCs, lifts all restrictions on core defence funding, as per the EU Commission recommendation. It is thus incumbent on the Greek government to join with

[60]Israel's Armed Forces are heavily reliant on their close collaboration with the US defence establishment, both in terms of military aid, which France could not provide to Greece, and in terms of close collaboration on the development of weapon systems, which France could offer Greece. For Israel's dependency, its military qualitative edge, infusions of cash and know-how from the US see, T.S. Allen, Here is how Israel's military dominates the battlefield, *The National Interest*, 27.2. 2018.

like-minded EU member-states, small, medium and large, and put its hands on the scales and help this come about, ideally within 2024.

Concluding Thoughts

By creating the HCDI, the Greek government will be implementing the first long-term industrial strategy based on R&D and substantially funded by national as opposed to mostly EU resources, in the history of Greek policy making.

We believe that this strategy has the ability to fulfil its promise, which is to catalyse innovation that can meaningfully improve the battlefield effectiveness of the Greek Armed Forces, and do so on the basis of the template created by the world's leading innovation nation, the US. Indeed, we argue that the MND has a fighting chance of becoming the first Greek government agency to substantially implement the practice of technology transfer in Greece—a practice which as mentioned above was established more than fifty years ago, in 1980, by the US through the Bayh & Dole Act, and has been disseminated globally since then.

In addition, we argue that precisely because the MND does not have the legacy of exceedingly complex and time-consuming procurement processes for the selection and acquisition of innovative defence products and services, like the highly advanced defence establishments of industrial democracies such as those of the US or the UK, it will be able to do so in a more flexible and time-sensitive manner, ideally mimicking the conflation of the innovation ecosystem with a nation's Armed Forces effected by Ukraine under the exigencies of war.

To do so, however, the Greek MND will need to confer a level of trust on the HCDI which is unprecedented by Greek standards of public life, and persist with radical organizational reforms of the Greek Armed Forces backed by fiscal allocations additional to the present defence budget. This might seem like a tall order. However, the very rationale that spurred on the creation of the HCDI is also the key guarantee of its eventual success. The prospect of Turkey adding, through its own innovation efforts, a qualitative advantage to the quantitative advantage it already enjoys over the Greek Armed Forces, combined with geopolitical ambitions on the part of Turkish policy makers that are unprecedented in the post WW II period, will in our opinion provide Greek policy makers with the consistency and integrity of effort required to ensure that innovation becomes core to the deterrence provided by the Greek Armed Forces.