The future of the European defense firm

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Abstract

The future European defense firm will be radically different, being determined by future threats, novel technology, and yet to come European defense policy. The immediate threat arises from the war in Ukraine, but longer-term European defense policy based on the Strategic Compass will provide the framework for the future European defense firm. Past developments offer some indication of the future and it is predicted that the defense firm has a future and will survive. The past trend of smaller numbers of larger defense firms will continue with firms being even more technologically-intensive—reflecting Augustine weapons systems, which are characterized by continuously rising unit costs and smaller volumes. There will be more mergers between European defense firms and more joint European projects developing and producing combat air and naval systems, tanks, and cyber systems.

The question is what might the future European defense firm look like? The future defense firm depends on a variety of factors such as threats, new technology, and national defense policy. All national defense policies have to respond to uncertainty and change. Uncertainty means that future threats are unknown and unknowable. They take different forms, in different locations, over different time periods requiring different defense budgets. New threats mean that defense policies have to change, adapting and adjusting to new challenges. Change might arise from a new political–strategic environment and new technology (e.g., the end of the Cold War, the emergence of drones, and new space systems). Overall, the future European defense firm will be determined by broad demand and supply-side factors. Broadly, demand-side factors will be represented by European defense policy and by future threats whilst supply-side factors will be represented by the costs of new technology, scale and learning economies, and the development of transaction costs. Aerospace firms are taken as typical of defense firms.

European Union defense policy

European Union defense policy has been characterized by change. For example, there was the 2003 European Security Strategy, the 2016 European Union Global Strategy, the 2016 European Defence Action Plan. and the 2022 EU Strategic Compass (EU, 2022). The Strategic Compass has some distinguishing features which affect the future European defense firm. It aims to develop an EU Rapid Deployment Capacity comprising up to 5,000 troops to be deployed for different types of crises. It will develop EU intelligence capacities, an EU Cyber Defence Policy, and an EU Space Strategy for security and defense. The Compass will also develop the next generation of capabilities in air, land, sea, and space domains (e.g., FCAS, advanced naval platforms, tanks, and space systems). EU cooperation with partners will be strengthened with partners named as NATO, UN, the United States, Norway, Canada, the United Kingdom, and Japan. The Strategic Compass was introduced at a time of war in Europe (i.e., Ukraine). By identifying future capabilities and partner nations, the Compass provides a framework for the future European defense firm.

Whilst the Compass presents a clear plan for future EU defense policy, it has two major deficiencies. First, like many previous European defense initiatives, it is good on rhetoric but lacks firm commitments and funding—offering an attractive but empty set of promises. Second, a Rapid Reaction Force of 5,000 troops is far too small and its tasks

are vaguely outlined. For instance, will it be used for worldwide operations and for what duration? Duration has major implications for the number of troops available for extended overseas deployments.[1] Nonetheless, the Strategic Compass will affect the development of the future European defense firm. It outlines future European demand-side prospects for defense firms; however, it is less specific on European supply-side prospects.

The future European defense firm will be determined by future threats, new technology, and future defense policy. The immediate threat is the war in Ukraine, but longer-term European defense policy, based on the Strategic Compass, will provide the framework for the future European defense firm. None of the Strategic Compass commitments are costless. Defense firms will continue to become more technologically intensive, with more mergers and joint European projects developing. Nationalism cannot be avoided, with nations responding to their national defense preferences—it may also constrain the choice of collaborative partners. However, cost pressures and defense budget constraints might lead to the choice of partner nations outside of the European Union.

Future threats

The Strategic Compass presents a comprehensive assessment of the likely future threats facing Europe. Threats include military aggression from Russia (e.g., cyber-attacks, energy coercion, and the Ukraine), threats from China, and threats from failed states such as Afghanistan and North Korea together with instability and poverty in Africa. Further multiple threats to Europe are recognized from terrorism, population migration, arms proliferation (nuclear weapons), and the weakening of arms control regimes. European defense firms will respond by developing new technologies to meet such threats. New equipment projects include next generation combat aircraft, strategic air transports (for rapid deployment of armed forces), new naval platforms, new tanks, smart ammunition, cyber systems, and space systems. But as Norman Augustine predicted, new military technologies will be costlier, which will affect the supply-side of the defense market.[2]

Costs of new technology

Augustine (1987) found that the unit cost of certain high technology equipment is increasing at an exponential rate with time. For example, the unit cost of high performance fighter aircraft has grown by a factor of four every ten years, with no ceiling in sight. Elsewhere, similar trends apply to helicopters, ships, tanks, and commercial aircraft but with a unit cost growth rate of a factor of two every ten years. Comparing trends in national defense budgets with unit costs led to Augustine's Final Law of Economic Disarmament or Impending Doom which predicted that by the year 2054, the entire defense budget will purchase just one aircraft (Augustine, 1987, p. 143). Other commentators have similarly forecast a future armed forces comprising a single ship navy, a single tank army, and Starship Enterprise or Battlestar Galactica for the air force (Kirkpatrick and Pugh, 1983).

Examples of unit cost data for U.K. combat aircraft are shown in Table 1. This demonstrates both rising unit costs in real terms between successive generations of combat aircraft and the actual levels of real unit costs. Combat aircraft are becoming costlier with fewer being acquired. For example, over 20,000 Spitfires (1940) were acquired compared with 160 Typhoons in 2003.3 Similarly for bomber aircraft, almost 8,000 Mosquitos (1943) were purchased compared with 136 Vulcans in 1954. Combat aircraft are also costly—reflected in the trade-offs compared with earlier generations of aircraft. A 2003 Typhoon cost the equivalent of some 8 Lightning aircraft of 1959, 26 Hunter aircraft

1 Typically, overseas troop deployments require a multiple of the numbers actually deployed. Overseas deployments require acceptable rotations so a 6 month overseas deployment requires at least another 1-2 troops for each one deployed overseas; and for a 6 month overseas deployment every 2 years requires at least another 4 troops for each one deployed overseas.
2 There is a view in the European Commission that the European Union is not in the business of collective defense. Instead, its focus is on a limited range of defense equipment aimed at reducing 'fragmentation.' In view of policies such as the Strategic Compass this is a strange view of EU defense policy.
3 Eurofighter is a European collaborative project with the four partner nations (U.K., Germany, Italy and Spain) purchasing 530 aircraft with exports of 151 units giving a total output of 681 units by 2019.

ISSN 1749-852X

of 1955, 68 Meteor aircraft of 1946, and 163 Spitfires of 1940. These changes were over 63 years (1940–2003) with costs rising by a factor of 163 between the Spitfire and Typhoon fighter aircraft. The trade-offs can be presented differently—a force of 160 Typhoon aircraft is equivalent to over 26,000 Spitfires or almost 11,000 Meteors or 4,150 Hunters or 1,260 Lightning aircraft.

Rising unit costs will affect the future defense firm, leading to more technology-intensive and costlier equipment with smaller volumes. As a result, defense firms will become more R&D-intensive and less production-intensive, leading to long-run outcomes such as Starship Enterprise or Battlestar Galactica (Markowski *et al.*, 2022). But this is not the only future scenario. Technical progress in defense equipment might mean a greater emphasis on drones and uninhabited air, land, and sea vehicles, some operating from Battlestar Galactica. This scenario still means a technology-intensive defense firm but with a continued production-intensity with cheap drones being produced in large numbers. Such impacts will not be confined to defense firms but will have wider implications for a nation's armed forces. Augustine weapons systems will change the military personnel requirements of the armed forces with greater demands for highly-skilled technology-intensive military personnel.

Table 1: United Kingdom unit costs for fighter and bomber aircraft

Aircraft	*Unit costs (£s 000s, 2018 prices)*	*Date*	*Cost factor*	*Time period (years)*
Fighters				
Spitfire	219.5	1940		
Meteor	529.7	1946	x2.4	6
Hunter	1,376.8	1955	x2.6	9
Lightning	4,539.7	1959	x3.3	4
Typhoon	35,737.9	2003	x7.9	44
Bombers				
Mosquito	355.2	1943		
Lancaster	714.9	1943	x2.0	0
Canberra	1,660.2	1951	x2.3	8
Vulcan	9,740.7	1954	x5.9	3
Tornado	12,930.5	1979	x1.3	25

Notes: Fighters and Bombers are U.K. fighter and bomber aircraft. The time gap between the Lightning and Typhoon was filled by the United Kingdom acquisition of the U.S. Phantom aircraft for which no data were available in the DSTL data set.
Unit costs are for airframes only, excluding other aircraft costs such as engines, avionics and landing gear.
Dates are for date of first production contract.
Cost factor is the increase in unit costs between successive generations. For example, Spitfire to Meteor and Meteor to Hunter.
Time period is gap in years between successive generations such as Spitfire to Meteor and Lancaster to Canberra.

Sources**:** DSTL (2010); Hartley, K. (2020)

Evidence on defense firms

Past trends offer some guidance of possible future trends and the role of uncertainty. In 1900, aircraft firms did not exist and defense industries comprised land and naval firms supplying land equipment in the form of artillery, guns, ammunition, and surface warships. Over time, the defense industry has been subject to technical change. Bows, arrows, and horse-mounted cavalry were replaced by cannons, rifles, machine guns, and tanks; sail-powered naval ships were replaced by steam-powered battleships and submarines emerged as a new form of warship with a shift from steam and diesel power to nuclear-powered propulsion.

The aircraft industry is an example of the emergence and rapid development of a new industry accompanied by new armed forces in the form of air forces. The industry developed with the first manned powered flight in 1903. It received major boosts to both output and technical progress from the World Wars and entry into space led to it being renamed the aerospace industry. Aerospace firms dominate the world's top arms companies such as Lockheed Martin, Boeing, Northrop Grumman, and BAE Systems. Over time, aerospace firms grew from one person enterprises to large corporations, during which they achieved economies of scale and learning with new and different organizational forms (leading to new efforts to economize on transaction costs). Governments determined demand-side market changes but firms also responded on the supply-side of the arms market.

Technical progress has been a further distinctive feature of the industry. Since its creation in 1903, it has developed aircraft which fly faster, further, higher, and can carry greater loads more safely (i.e., weapons and passengers). Technical progress led to entry into new markets, especially space, jet engines, rocket power, and uninhabited air vehicles—all achieved in 120 years. Novel technology in design and manufacturing will result in a reduced importance of labor inputs in the production function. New materials and automation mean the substitution of labor with capital (machinery) and fewer opportunities for traditional labor learning. All these changes are costly, and increasingly the costs of change are borne by government.

Table 2(a): ***Top 10 arms companies, 2002***

Company	*World Rank*	*Arms Sales (USDm)*	*Arms Sales as share of total sales (%)*
Boeing	1	35,351	44
Northrop Grumman	2	31,510	93
Lockheed Martin	3	28,314	71
BAE Systems	4	22,416	77
Raytheon	5	18,036	72
General Dynamics	6	14,735	71
Thales	7	11,083	65
United Technologies	8	8,463	20
EADS	9	9,217	20
Honeywell International	10	5,582	17
Average		**18,474**	**68**

Notes: Data for 2002 excludes China. Chinese top arms companies entered SIPRI rankings from 2015.
Ranking based on arms sales for 2002 shown in 2021 prices.
EADS ranking was sensitive to the price index.
Average is for Top 10. Average for arms sales share based on median.

Government is central to understanding aerospace and defense industries. It determines the demand for aerospace and defense equipment and can use its buying power to determine the size, structure, conduct, performance, location, and ownership of the industry (Hartley, 2014). Over time, arms companies have become larger and their numbers have declined through acquisitions, mergers, and exits; it is likely that such structural changes will continue. Tables 2 (a) and (b) present examples of structural change amongst the world's top 10 arms companies between 2002 and 2021.

A comparison of the 2002 and 2021 data (Tables 2(a) and (b)) shows changes in company names, company rankings, and the average size of firm. EADS (European firm) changed its name to Airbus and United Technologies merged with Raytheon to become Raytheon Technologies. For company rankings, Boeing was the top world arms company in 2002 but was ranked third in 2021. Similarly, Lockheed Martin was ranked third in 2002 but was the top company in 2021. And over the period, the average size of firm within the top 10 increased by almost 60% in real

terms and their defense dependency declined substantially. Similar changes occurred when comparisons are made with the top 10 firms at an earlier date. In 1995, the top 10 firms were in rank order: Lockheed Martin; McDonnell Douglas; British Aerospace; Loral; General Motors; Northrop Grumman; Thomson; Boeing; GEC; and Raytheon (tenth rank). Again, between 1995 and 2002, there were name changes and acquisitions. McDonnell Douglas was acquired by Boeing; British Aerospace became BAE Systems after the acquisition of GEC–Marconi; Loral became part of L3 Harris; and Thomson became Thales.[4] Overall, the major aerospace firms dominated the world's top 100 arms producers. Increasingly, the major aerospace firms entered other arms markets, such as land, sea systems, electronics, and cyber.

Comparing the nationality of firms over the period 2002 to 2021, the most striking result is the crowding-out of European firms from the top 10. This partly reflects the inclusion of Chinese firms and that European defense firms are perceived as being too small. In 2021, only one European firm ranks in the top 10 (BAE Systems). It is also notable that there are no IT firms in the world's top companies.

European defense firms face two types of competition. First, top level competition from U.S. and Chinese firms and second, competition from the bottom from emerging countries such as Israel, South Korea, and Turkey. In coming years, competition will be a major driver and challenge for the future European defense firm. European collaborative defense projects are a possible solution.

Table 2(b): ***Top 10 arms companies, 2021***

Company	*World Rank*	*Arms Sales (USDm)*	*Arms Sales as share of total sales (%)*
Lockheed Martin	1	60,340	90
Raytheon Technologies	2	41,850	65
Boeing	3	33,420	54
Northrop Grumman	4	29,880	84
General Dynamics	5	26,390	69
BAE Systems (United Kingdom)	6	26,020	97
NORINCO (China)	7	21,570	26
AVIC (China)	8	20,110	26
CASC	9	19,100	44
CETC (China)	10	14,990	27
Average top 10		**29,367**	**60**
Average top 5		**38,376**	**65**

Notes: Data for 2021 include major Chinese arms companies and BAE Systems of the United Kingdom. All remaining firms in Top 10 are U.S. arms companies.
Time period 2002 to 2021 chosen because data available from SIPRI with 2002 sales data in 2021 prices.
Arms sales in 2021 prices. Arms shares of totals are medians.
See also Notes for Table 2(a).

Future European joint projects

European joint projects offer economic benefits but at political costs. Economic benefits arise from the expected cost savings from sharing total development and production costs. In the simple case, two or more nations agree to share the total costs of some new equipment, such as an aircraft, warship, or tank. To date, most completed European joint defense projects have been joint ventures for aerospace projects between a small number of European states, usually comprising France, Germany, Italy, Spain, and the United Kingdom. Examples include the two nation Jaguar strike

4 The 1995 data are not reported since they were not presented by SIPRI on the same basis as the 2002-2021 data.

aircraft (France–United Kingdom), the three nation, multi-role Tornado (Germany, Italy, and the United Kingdom) and the four nation Eurofighter Typhoon (Germany, Italy, Spain, and the United Kingdom). Aerospace collaboration offers cost savings in development together with scale and learning economies in production compared with similar national projects. In a two nation example with equal sharing, development costs are divided equally between the two nations and production orders are combined from, say, 200 aircraft each, to give a combined total of 400 units. In principle, for each nation development costs are halved and unit production costs might be some 10% lower due to scale and learning economies (compared with two separate national projects).

Collaboration involves costs as well as benefits, with the ideal case being seldom achieved. Partner nations will have national requirements for work sharing, reflected in their demands for a share of new technology and production work, aimed at providing benefits for their national defense industrial base and their "national champions". The result might be reflected in duplicate flight test centers and final assembly lines, both reflecting departures from the allocation of work on a least-cost basis. Organization and management arrangements will reflect complex transaction costs as partners negotiate compromises about operational requirements, time schedules, work, and budget sharing. Overall, transaction costs reflect the fact that collaboration is a painful process, with each partner making sacrifices. Transaction costs are especially relevant for analyzing collaborative projects, since they involve complex international contracting. Collaboration costs are recognized by the European Defence Fund, which offers small amounts of funding to "incentivize" partner nations to collaborate through research windows.

Public choice analysis provides one explanation of the economic and non-economic features of collaborative projects. It identifies agents in the political marketplace and their behavior within the military–industrial–political complex (MIPC). The agents comprise voters, politicians, bureaucracies, and producer groups. For instance, budget-maximizing bureaucracies, in the form of the armed forces and government defense ministries, have incentives to over-estimate the threat and under-estimate project costs. Once started, collaborative projects are difficult to stop—exit might be costly for any one partner nation. International collusion replaces rivalry and national governments will be confronted with interest groups of scientists, contractors, and trade unions in each partner nation. Such international groups of experts will seek to influence vote-conscious national governments with the technological, military, and economic benefits of continuing with a collaborative project (e.g., employment and exports).[5] The outcomes of complex international bargaining between agents in the MIPC has resulted in inefficient work-sharing and management arrangements. Inefficiency has been reflected in the duplication of flight testing centers and final assembly lines (*juste retour*), additional management and organizational costs, delays due to design and management by committee as well as compromises in agreeing operational requirements, budget-sharing, and delivery schedules (Bellais, R. 2022; Matthews and Al-Saadi, 2021).

Assessing collaborative projects is difficult since there is only a small sample of projects for empirical analysis. The sample involves different types of projects (e.g., combat and trainer aircraft, transports, helicopters, and missiles) and different partner nations (France, Germany, Italy, Spain, the United Kingdom). Furthermore, there is the problem of the counter-factual, i.e., what would have happened without the collaborative project? For example, without the four nation Eurofighter Typhoon aircraft, would each of the partner nations have built an identical aircraft, buying the same quantity in the same time-scale; or would they have imported a U.S. combat aircraft (from a choice of the F-15, F-16 or F-18)? Further, collaborative projects need to be subject to the opportunity cost question: what is the alternative use value of the resources used in collaboration? This question is more easily asked than answered.

5 Hartley (2017)

Future European combat aircraft

Currently, two groups of European nations are developing two new combat aircraft known as the Tempest (or the future combat aircraft, FCA) and the future offensive air system (FOAS). These two projects will determine the future European aerospace firms and the European combat aircraft market. They show that the European combat aircraft market has consolidated around two major projects instead of the previously three independent programs (i.e., Gripen, Rafale, and Typhoon). The challenge is whether two projects are sufficiently viable to survive.

At the time of writing, the national groupings are the United Kingdom with its Team Tempest aircraft (FCA) and France and Germany with their FOAS. The United Kingdom led Team Tempest project is a sixth generation combat aircraft involving the United Kingdom, Italy, and Sweden with Japan as a further possible partner nation. It is planned to be flexible, capable, and affordable with innovative systems embracing manual and unmanned flight and will replace Typhoon. Launch was in 2018 with a planned in-service date of around 2040. The major companies involved in Team Tempest are BAE Systems, Rolls-Royce, Leonardo, MBDA, and Mitsubishi. Manufacturing will be based on the "factory of the future" using advanced manufacturing capabilities.

The European FOAS (also known as the Next Generation Fighter or NGF) is also a sixth generation combat aircraft designed to replace Typhoon and Rafale aircraft. France, Germany, and Spain are the partner nations involving Dassault Aviation as lead firm together with Airbus, Indra Systems, Safran, MTU Engines, Thales, and MBDA. In-service date is planned for 2040/45.

Inevitably, questions arise about whether the European nations and the United Kingdom can afford to develop two similar but costly combat aircraft—hence the case for collaboration. Both aircraft are designed to meet similar operational requirements in similar time-scales. Two aircraft will involve two R&D bills and smaller production runs compared with all nations agreeing to develop one combat aircraft and combining their national production quantities. Development costs for each aircraft type may exceed £300 billion.[6] But collaboration would increase total development costs by some 50% for each participating nation.[7] Also, Augustine forecast unit costs rising by a factor of four every 10 years. If development takes 20 years, unit production costs might reach £1.6 billion (based on Typhoon unit production costs of £100 million in 2022 prices). Such unit costs mean each nation will only be able to afford small quantities, say, 50–100 units per nation.[8]

Collaboration also requires the partner nations to reach agreement about a common operational requirement which often forms a barrier to any agreement, especially between France and the United Kingdom with traditional disputes over design leadership (i.e., between Dassault and BAE Systems on airframes; Rolls-Royce and Safran on aero-engines). The eventual outcome of the European rivalry in the combat aircraft market will have implications for the future European defense firm.

Future European defense firms

Forecasting faces uncertainty, and as no one can accurately predict the future, today's sunrise industries will be tomorrow's sunset industries—inevitably all forecasts will be wrong.[9] Nonetheless, some broad generalizations are possible using the past as an indicator of future trends in the period to 2050.

The first prediction is that the defense firm has a future. Unless there is an unexpected outbreak of world peace maintainable without a world military policing organization, the defense firm will survive although its future form

6 2022 prices from Pugh (2007, p. 86) which provides a formula used to estimate the relationship between development costs and unit production costs.
7 Pugh (2007, p. 87).
8 These cost estimates are illustrative only and are meant to provide orders of magnitude.

9 An earlier version of this article appeared in 2003: Hartley and Sandler (2003).

could change. Even a limited world policing organization would require modern weapons to enforce world peace. The surviving defense firm will be a different form of organization, using innovative forms of information technology leading to a new form of the modern corporation. It will adjust to new epidemics such as novel forms of Covid, to new national commercial laws, and greater "working from home". But for defense firms, "working from home" will be limited for some personnel as firms become more technically-intensive where costly technologies and physical capital inputs are provided internally by the firm (e.g., testing facilities and final assembly plants which are not available "at home").

The second prediction is that the future defense firm will be the result of changes in threats and changes in technology. New threats will emerge from different nations and groups. The Russian invasion of Ukraine in 2022 is an example of a new threat leading to NATO nations adjusting to the re-emergence of Russia as a military threat in Europe. Longer term future threats are much more difficult to predict; the European Strategic Compass outlined possible future threats for European defense firms, but inevitably cannot predict the unknown and unknowable. However, the Strategic Compass outlined a future for European firms supplying modern combat aircraft, new warships, and new tanks.

Novel technology is a further source of change. The armed forces will need to adjust and respond to new forms of weapons. Some technologies represent threats to the traditional activities of some branches of the armed forces; for instance, tanks and helicopters were a threat to cavalry regiments and a failure to adapt leads to defeat in conflict. Similarly, new technology represents a threat to the traditional business of some defense firms and failure to adapt and respond results in exit from the industry. Here, the costs of new technologies will be a factor in firm survival. Costly technologies such as Augustine weapons systems (Battlestar Galactica) are likely to be beyond private financing and will require substantial government funding. Other cheaper technologies will be within the financing of private firms and their survival depends on entrepreneurship. State-owned firms are less likely to be as entrepreneurial as private companies, but state-owned firms will be less constrained by budgets.

Change provides fresh market and profitable opportunities for defense firms. They will respond by creating new businesses or acquiring firms already established in emerging markets (i.e., acquisitions and mergers). Space systems provide another market opportunity, especially in satellite surveillance, navigation, and communications. Despite international agreements preventing the deployment of weapons in space, it is possible that such restrictions will not continue indefinitely or that nations might not observe international conventions, especially since there are first mover advantages.

The third prediction is a continuation of the long-run trend toward a smaller number of larger defense firms resulting in supply-side changes. As such, Augustine weapons systems will be a major driver of such trends. Increasingly, rising costs mean that national independence becomes too costly. For European defense firms, these changes will be reflected in more European-wide mergers, especially with European defense policy favoring less fragmentation of weapons systems (i.e., greater standardization of weapons with fewer new types). The search for less fragmentation within European defense markets will also lead to more collaborative defense projects, especially involving land and sea systems (e.g., tanks, armored fighting vehicles, and warships). The future market for advanced combat aircraft offers opportunities for collaboration amongst European, U.K., and U.S. defense firms. Rising costs of defense equipment might result in international mergers between European and U.S. firms with other possibilities involving Japan, Turkey, South Korea, and India. Such international mergers will raise new regulatory challenges. For example, there will be challenges in determining the profitability of international defense contracts. Nations have different rules for determining the profitability of non-competitive defense contracts and different arrangements for auditing profits.

There will be challenges in maintaining a national defense industrial base. For example, if the European Union wishes to maintain a defense industrial base for strategic and other reasons, it will have to be prepared to bear its

costs. Problems arise when the industry is faced with the downturn in sales which happens between major projects. Various policy options can be used to retain the industry, such as additional production orders for existing projects, ordering new technology demonstrators, or the "mothballing" of plants. None of these policies are costless. Mothballing of plants appears to be a cheap option but it also creates problems. Retaining a mothballed plant involves costs to maintain and police the physical plant and equipment. Also, when a mothballed plant is required for production, a new labor force needs to be recruited and trained, involving costs and time. Next, the costs of retaining an EU defense industrial base have to be estimated and member nations have to pay; member states need to agree how costs are to be shared and free riding avoided. The alternative to supporting an EU defense industrial base is to import defense equipment, most likely from the United States, which conflicts with the EU preference for strategic independence.

Another prediction is that company names will change and that new entrants will emerge, possibly from the information technology sector. The future defense firm will be radically different. In terms of new names, it has to be remembered that a century ago, Boeing, Lockheed Martin, BAE, and Airbus did not exist. The next generation of new entrants might be electronics and IT companies or large civil firms initially without any defense activities. There will be a focus on more profitable defense activities such as systems integration rather than "metal bashing" forms of manufacturing (e.g., robotics in the future factory).

Two general forms of defense company are likely to emerge. One is the highly specialized defense company with a range of defense activities (e.g., air, land, sea, and space systems). The other form is a diversified defense–security business with a substantial civil business providing insurance against downturns in defense sales. Mergers and acquisitions will involve acquisitions of different types of business such as the acquisition by airframe companies of aero-engine, missile, and helicopter companies in the aerospace industry (e.g., BAE acquiring Rolls-Royce in the United Kingdom). Defense firms are likely to acquire new technologies created by other firms rather than other firms entering the defense market. Such a development reflects entry barriers into defense markets resulting from the complexity of defense products even for new large technologies firms (Hobday, 1998).

Conclusion

The above predictions suggest that the future European defense firm will be different. Future firms will be as different as today's firms are as different from those of 1945, and more so compared with firms that were active in 1900. The European Strategic Compass will be a key determinant of the future European defense firm (probably to be termed defense and security firms). The Compass outlines the EU's Strategic Vision to 2030 and provides a framework for the future defense firm, where there will be more and better defense spending with projects being better defined and increasingly delivered as joint European projects. There will be a future for combat air systems, naval platforms, space capabilities, and tanks; these will be a focus for joint projects. New technologies will emerge with more emphasis on cyber warfare, such as artificial intelligence and quantum computing. There will be a continued support for an EU defense and technology industrial base which will benefit European defense firms. In the short term, the future firm will be affected by the conflict in the Ukraine with an emphasis on the production of existing weapons and the development of new systems arising from the Ukraine experience (e.g., various types of drones).

None of the Strategic Compass commitments are costless. Support for an EU defense industrial base cannot ignore the costs of maintaining the industry during troughs in project work. Costs of buying from Europe will also be apparent when the alternative of importing cheaper equipment is an option (e.g., from the United States). Nor will a European rapid reaction force be costless; it will need military personnel and new standardized equipment both of which raise major problems for any EU defense policy. These include trust, free riding, and nationalism. Trust is needed for any international military alliance; all partners need to be confident that their allies will turn up in any military conflict. Free riding means that smaller partners have every incentive to shift defense spending to their larger

allies. Nationalism cannot be avoided and will mean that nations will respond to their national defense preferences rather than the preferences of the collective alliance (especially where conflict involves deaths and injuries of European military personnel). Nationalism might also constrain the choice of partners for collaboration. Typically, European nations prefer European partners; but cost pressures and defense budget constraints might lead to the choice of partner nations outside of the European Union (e.g., Japan and the United Kingdom).

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