

## **Innovation and Growth in a Dual Technologies Scenario: Civil and Military top Advanced Industries Competition\***

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The 2019 edition of the Bourget Air Show<sup>1</sup> and the parallel almost war collision US-Iran in the Strait of Hormuz gave a full pictures of the shifting in civil and military industrial more advanced productions by the top world groups leading the global market of dual technologies for space, airplanes, advanced cars, medical equipment, environment, digital, quantum and hypersonic vehicles. Less parade style to showing but much more telling on the future of the third industrial revolution ongoing. The AI perspective and the 5G<sup>2</sup> tensions are only titles of the open competition over some of the highest technologies, as this Report from the Euro Parliament pictured<sup>3</sup>.

Not to mention the defence and military side scenario. The future recently unveiled shows an impressive evolution. The silent uprising of new, advanced, sophisticated technologies pushed for decisive changes in the strategies of the main civil and defence “actors” of the geopolitical and military world scenarios. It impacted as a rude awakening call in Europe but resulted into an increased international competitiveness and growing shares of the global markets in top sectors. In fact, EU<sup>4</sup> data diffused in May shows the primacy in international trade

<sup>1</sup> <https://www.siae.fr/en/>

<sup>2</sup> <https://www.reuters.com/article/us-qualcomm-m-a-broadcom-5g/what-is-5g-and-who-are-the-major-players-idUSKCN1GR11N;>

<sup>3</sup> [https://www.europarl.europa.eu/RegData/etudes/IDAN/2019/631060/IPOL\\_IDA\(2019\)631060\\_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/IDAN/2019/631060/IPOL_IDA(2019)631060_EN.pdf)

<sup>4</sup> <http://ec.europa.eu/trade/policy/eu-position-in-world-trade/>

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and a close standing in total GDP with US <sup>5</sup>. The Gross Domestic Product (GDP) in European Union was worth 18748.57 billion in US dollars in 2018. The GDP value of European Union represents 22.24 percent of the world economy. China achievements had been as well outstanding in 2018, with GDP at \$ 13.407 billion and trade to \$2.494 trillion.

I open a quick window on the last quarter 2019 compared to 2018 both for European Union and China versus U.S. The datas for EU are very interesting and not so frequently evoked in official statements of in the media<sup>6</sup>. “The first estimate for Euro area (EA19) exports of goods to the rest of the world in April 2019 was €192.9 billion, an increase of 5.2% compared with April 2018 (€183.4 bn). Imports from the rest of the world stood at €177.2 bn, a rise of 6.6% compared with April 2018 (€166.3 bn).

As a result, the Euro area recorded a €15.7 bn surplus in trade in goods with the rest of the world in April 2019, compared with + €17.1 bn in April 2018. Intra-euro area trade rose to €163.7 bn in April 2019, up by 3% compared with April 2018<sup>7</sup>. Reading the official data diffuse recently by Eurostat, a fully trustable source. EU-China trade moved on in the first part of this year better then in the same part of 2018, with a net margin favorable to China as you can se from the slide.

But what about US *versus* EU and China *versus* US? I asked myself these questions before preparing my draft paper in last July. Let’s see quickly.

- U.S. goods and services trade with the EU totaled nearly \$1.3 trillion in 2018. Exports totaled \$575 billion; Imports totaled \$684 billion. The U.S. goods and services trade deficit with the EU was \$109 billion in 2018<sup>7</sup>. The EU countries, together, would rank 1st as an export market for the United States in 2018. And what about China and US, in the same y.o.y comparative exercise?
- *Customs core data for the first quarter of 2019*. According to customs statistics, the total value of China’s imports and exports in the first quarter of this year was 7.01 trillion yuan, an increase of 3.7% over the same period last year. Among them, exports were 3.77 trillion yuan, up 6.7%; imports were 3.24 trillion yuan, up 0.3%; trade surplus was 529.67 billion yuan, up 75.2%; in dollar terms, in the first quarter, China’s total import and export value was 1.03 trillion US dollars, down 1.5%. Among them, exports were 551.76 billion US dollars, an increase of 1.4%; imports were 475.45 billion US dollars, down 4.8%; trade surplus was 76.31 billion US dollars, an increase of 70.6%.

Again, also in the USA - China flows data the overall values are quite balanced, even if much far from the respectively before forecast ones. On the commercial and services trade the maneuvers due to reciprocal tariffs highering there was no significative impact in the short-medium range.

<sup>5</sup> <https://tradingeconomics.com/european-union/gdp>

<sup>6</sup> [http://trade.ec.europa.eu/doclib/docs/2013/december/tradoc\\_151969.pdf](http://trade.ec.europa.eu/doclib/docs/2013/december/tradoc_151969.pdf) ; <http://ec.europa.eu/trade/policy/eu-position-in-world-trade/>

<sup>7</sup> <https://ustr.gov/countries-regions/china-mongolia-taiwan/peoples-republic-china>

## Summarizing US trade with China and European Union<sup>8</sup>

In fact, it's really what we have read in the data of the first semester 2019. But the effective evaluations of the net results for U.S. and China "trade war" will be seen in a longer span of 2020.

But is the reality of U.S, trade balance that is negative and not performing as it should. Let us read the very recent dataset of U.S. versus European Union and China and the deficit that appear so evident and not faced with appropriate policies in the last twenty years. In fact, a sound strategy on competitiveness, innovative products and dual-technology, environment, value chains in wide sectors of advanced industrial production outcomes would give in the medium term much better result than any "trade barrier, dispute or clashes on tariffs".

### 2019 : U.S. trade in goods with China

Month	Exports	Imports	Balance
January 2019	7,134.3	41,603.8	-34,469.5
February 2019	8,433.6	33,194.4	-24,760.8
March 2019	10,426.5	31,175.7	-20,749.1
April 2019	7,896.3	34,798.9	-26,902.6
May 2019	9,074.5	39,269.1	-30,194.6
June 2019	9,034.7	39,002.3	-29,967.6
<b>TOTAL 2019</b>	<b>52,000.0</b>	<b>219,044.3</b>	<b>-167,044.3</b>

*NOTE: All figures are in millions of U.S. dollars on a nominal basis, not seasonally adjusted unless otherwise specified. Details may not equal totals due to rounding. Table reflects only those months for which there was trade*

### 2018 : U.S. trade in goods with China

Month	Exports	Imports	Balance
January 2018	9,902.6	45,765.6	-35,863.1
February 2018	9,759.9	39,020.6	-29,260.7
March 2018	12,652.1	38,327.6	-25,675.5
April 2018	10,503.8	38,303.9	-27,800.1
May 2018	10,428.2	43,965.7	-33,537.5
June 2018	10,860.1	44,612.1	-33,752.0
July 2018	10,134.6	47,120.6	-36,986.0
August 2018	9,285.9	47,869.2	-38,583.3
September 2018	9,730.0	50,015.0	-40,285.0
October 2018	9,139.9	52,202.3	-43,062.5

<sup>8</sup> <https://www.census.gov/foreign-trade/balance/c5700.html> ; <https://www.census.gov/foreign-trade/balance/c0003.html>

Month	Exports	Imports	Balance
November 2018	8,606.2	46,500.8	-37,894.6
December 2018	9,144.9	45,972.1	-36,827.2
<b>TOTAL 2018</b>	<b>120,148.1</b>	<b>539,675.6</b>	<b>-419,527.4</b>

NOTE: All figures are in millions of U.S. dollars on a nominal basis, not seasonally adjusted unless otherwise specified. Details may not equal totals due to rounding. Table reflects only those months for which there was trade.

### 2019 : U.S. trade in goods with European Union

Month	Exports	Imports	Balance
January 2019	27,836.0	39,490.6	-11,654.6
February 2019	28,523.3	37,678.4	-9,155.2
March 2019	30,589.3	44,765.4	-14,176.2
April 2019	27,280.7	44,968.8	-17,688.1
May 2019	28,352.1	45,518.3	-17,166.2
June 2019	27,419.5	41,431.7	-14,012.2
<b>TOTAL 2019</b>	<b>170,000.9</b>	<b>253,853.3</b>	<b>-83,852.5</b>

NOTE: All figures are in millions of U.S. dollars on a nominal basis, not seasonally adjusted unless otherwise specified. Details may not equal totals due to rounding. Table reflects only those months for which there was trade.

### 2018 : U.S. trade in goods with European Union

Month	Exports	Imports	Balance
January 2018	23,377.4	36,867.7	-13,490.3
February 2018	24,911.6	36,939.2	-12,027.6
March 2018	30,013.1	41,827.7	-11,814.6
April 2018	26,744.1	41,437.6	-14,693.5
May 2018	27,970.4	41,066.3	-13,095.9
June 2018	28,123.2	40,037.6	-11,914.4
July 2018	23,861.2	41,528.7	-17,667.5
August 2018	25,604.5	41,245.7	-15,641.2
September 2018	27,017.6	37,680.0	-10,662.3
October 2018	28,042.1	45,392.0	-17,349.9
November 2018	26,877.7	42,042.9	-15,165.2
December 2018	25,833.4	40,971.3	-15,137.9
<b>TOTAL 2018</b>	<b>318,376.3</b>	<b>487,036.7</b>	<b>-168,660.4</b>

NOTE: All figures are in millions of U.S. dollars on a nominal basis, not seasonally adjusted unless otherwise specified. Details may not equal totals due to rounding. Table reflects only those months

*for which there was trade.*

These datasets are very significant and comment in a remarkable way the scenario in which the dispute on foreign trade between U.S. and China from one side and with European Union on the other side is moving and has great relevance on competitiveness and future developments. For sure any “trade war” might be resolving these unbalances so clearly shown by the data diffused by from U.S. census.gov but only wider global trade policies and negotiations would drive the world into the safe harbour of governance instead of disputes.

We go back to the paper. We are analyzing a process full of implications for advanced Economic, Financial and Industrial studies and researching as well in International Relations and Political Governance theories and practices, while investment in the defense sectors and for the forthcoming “dual” technologies, already available on an industrial scale, will modify on global scale the perspective real balance of power.

From a stage to the next, future scenario was unveiled showing an impressive evolution. The silent uprising of new, advanced, sophisticated technologies pushed for decisive changes in the strategies of the main civil and defence “actors” of the geopolitical and military world scenarios. It impacted as a rude awakening call in Europe but resulted into an increased international competitiveness and growing shares of the global markets in top sectors.

A process full of implications for Economic, Financial and Industrial studies and researching as well in International Relations and Political Governance theories and practices, as investments in the defense sectors and for the forthcoming “dual” technologies, already available on an industrial scale, start to be available on an industrial scale, then modifying on global scale the perspective real balance of power. I have found very much innovative the approach recently presented by Accenture - one of the top main corporate advisory company worldwide in governance, strategy, consulting, digital, technology and operations, solutions for low-carbon economy and lessening the effects of climate change – in the very telling Report: “Harness the engine of Innovation”<sup>9</sup>. I will then better focus on the civil-defense multisector that the focus of this paper presentation at the Singapore Economic Review Conference 2019<sup>10</sup>.

The Accenture preface on its aims and scope, by the way, is fitting well to our considerations on value chains here in a protagonist Country in evolutionary aspects in industrial civil and defence advancements. *“In today’s tumultuous times, where aerospace and defense companies are contending with myriad challenges - from insurgent competitors and breakneck technological change to geopolitical instability - being relevant is essential. That’s why many in the industry are working furiously to come up with new and innovative ways to serve the needs of their customers, suppliers, partners and workforce at those high-value touch points or “moments that matter.” In this way, they are becoming more like living businesses, building and sustaining*

<sup>9</sup> Accenture, Harness the Engine of Innovation, Report 2019; <https://www.accenture.com/us-en/insights/high-tech/tech-vision-aerospace-defense>

<sup>10</sup> [http://www.serconf.org/2019/about\\_ser.html](http://www.serconf.org/2019/about_ser.html)

*symbiotic ties with their stakeholders as if those relationships were with dear friends. With every business embracing the importance of digital transformation, companies need to look toward their next opportunity for differentiation momentary markets.*

*Internally, this means preparing the organization to be a truly agile company with the capabilities to identify opportunities and deliver exactly what customers want. In other words, they're striving to become more like living businesses to build and sustain symbiotic ties with every stakeholder on another level, living businesses enable responsive innovation, allowing companies to get ahead of the curve in markets by creating a culture and infrastructure that continuously embrace new ideas, behaviors and technologies. Lower-cost space launches from Blue Origin and SpaceX are great examples of responsive innovation. Both enable the acceleration of new communications and earth observation services at revolutionary price points and at an unprecedented pace in their ecosystem. Internally, this means preparing the organization to be a truly agile company with the capabilities to identify opportunities and deliver exactly what customers want. In other words, they're striving to become more like living businesses to build and sustain symbiotic ties with every stakeholder on another level, living businesses enable responsive innovation, allowing companies to get ahead of the curve in markets by creating a culture and infrastructure that continuously embrace new ideas, behaviors and technologies.*

*Lower-cost space launches from Blue Origin and SpaceX are great examples of responsive innovation. Both enable the acceleration of new communications and earth observation services at revolutionary price points and at an unprecedented pace in their ecosystem. That granularity of understanding will allow aerospace and defense companies to meet stakeholders in their moment of need in a post-digital world to in fact become a different business to every single customer. It is all about choosing the right moments. How will your company choose them? By conveying exactly the right message or offer in exactly the right context. And delivering truly intelligent experiences that shape offerings and adapt in real time to the needs and preferences of customers, partners, suppliers and employees.*

*It's about the moments that matter, whether that's using Big Data to predict when an aircraft will need maintenance, or deploying augmented-reality to provide over-the shoulder coaching to field technicians or mechanics on the other side of the world. To create intelligent experiences and responsive innovation, companies need to become agile, shifting to a more fluid, nimble and open relationship model that enables dynamism across the organization, its partners and customers.*

*Ultimately, a company's infrastructure will be primed to embrace new ideas and technologies and anticipate and respond to changing customer and market opportunities. Consider the example of Airbus Aerial, which fuses a space-based, earth observation satellite fleet with unmanned aircraft to create timely and actionable data for its customers, such as disaster response or being able to perform runway maintenance under extremely tight timeframes”.*

*And more hints on business models: “The aftermarket continues to see strong interest by the OEMs and prime contractors to take a bigger piece of the \$175 billion global commercial and military MRO market. Lagging aircraft retirements and additional shop visits for older aircraft will provide more opportunity for cost-competitive maintenance providers. Business models such as Boeing's US trainer aircraft award*

*relies heavily on in-service sustainment sales to offset low production prices. Behind all these developments lie the disruptive innovation and new business models reshaping aerospace and defense's future. Across the board, aerospace and defense businesses are investing in digital to drive innovation. They are deploying innovation labs or digital accelerators. In fact, according to our research, 70% of aerospace and defense executives agree social, mobile, analytics and cloud (SMAC) have moved beyond adoption silos to become part of the core technology foundation for their organizations. Aerospace and defense companies are broadening the diversity and combination of advanced technologies that they are explored.”(End Accenture quotation. Annex with tables in last pages of the paper)*

## **Glossary<sup>11</sup>**

### ***DLT – Distributed Ledger Technologies***

The progress of mankind is marked by the rise of new technologies and the human ingenuity they unlock. In distributed ledger technology, we may be witnessing one of those potential explosions of creative potential that catalyse exceptional levels of innovation. The technology could prove to have the capacity to deliver a new kind of trust to a wide range of services. As we have seen open data revolutionise the citizen's relationship with the state, so may the visibility in these technologies reform our financial markets, supply chains, consumer and business-to-business services and publicly-held register.

[https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/492972/gs-16-1-distributed-ledger-technology.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/492972/gs-16-1-distributed-ledger-technology.pdf)

### ***Ai – Artificial Intelligence***

Artificial intelligence (AI) is an area of computer science that emphasizes the creation of intelligent machines that work and react like humans. Some of the activities computers with artificial intelligence are designed to including: Speech recognition; Learning; Planning, Problem solving

<https://www.techopedia.com/definition/190/artificial-intelligence-ai>

### ***XR - Extended reality***

Extended reality (XR) is a term referring to all real-and-virtual combined environments and human-machine interactions generated by computer technology and wearables. It includes representative forms such as augmented reality (AR), augmented virtuality (AV) and virtual reality (VR).

### ***Quantum Revolution***

The integration of quantum technologies currently represents one of the most anticipated advances for armed forces, yet their precise impact remains difficult to predict. Although economical applications and widespread use are still years away, there is little doubt that they will have disruptive effect when they are employed at

<sup>11</sup> Transition Studies Research and Network

scale. In May 2018, the head of quantum computing at technology firm Intel suggested that ‘if 10 years from now we have a quantum computer with a few thousand qubits, that would certainly change the world in the same way the first microprocessor did’. (A qubit, or quantum bit, is the basic unit of information in a quantum computer, analogous to a bit in a standard computer.) But while quantum technology is expected to eventually have far-reaching effects for military forces, intelligence services and law-enforcement agencies, it is unclear how far it will alter the traditional balance of power among states, or between states and non-state actors.

<https://www.iiss.org/publications/the-military-balance/the-military-balance-2019/quantum-computing-and-defence>

### **Dual-technologies main categories**

And we also need to clarify which are roughly the dual-technologies main categories and sectors. This horizon defines already the appropriate concept of an already advanced fourth-generation industrial revolution.

The patent approach looks at whether or not a patent is high-tech and also defines biotechnology patents. The groups are put together on the basis of the International Patent Classification (IPC)<sup>12</sup>, 8th edition, as are biotechnology patents. Subsequent technical fields are defined as high-technology IPC groups and I integrated with some other others:

- aviation
- communication technology
- computer and automated business equipment
- lasers
- micro-organism and genetic engineering
- semiconductors
- cars engines and innovative transportation tech
- turbines and engines
- space vehicles
- energy production and alternatives
- medical high-tech applications

Then we move to the crucial issue: Emerging technology dominance: what China’s pursuit of advanced dual-use technologies means for the future of Europe’s economy and defence innovation<sup>13</sup>. And an interesting following question and answers reading: “Risky business? The EU, China and dual-use technology”<sup>14</sup> and SIPRI “Dual-use and arms trade control”<sup>15</sup>. All that said, being the focus of this Conference on “Industrialization and the Expansion of Global Value Chains” with reference to China, I introduce immediately three main question marks in this paper.

<sup>12</sup> <https://www.wipo.int/classifications/ipc/en/>

<sup>13</sup> [https://www.merics.org/sites/default/files/2018-12/181218\\_Emerging\\_technology\\_dominance\\_MERICS\\_IISS.pdf](https://www.merics.org/sites/default/files/2018-12/181218_Emerging_technology_dominance_MERICS_IISS.pdf)

<sup>14</sup> <https://www.iiss.europa.eu/sites/default/files/EUISSFiles/op80.pdf>

<sup>15</sup> <https://www.sipri.org/research/armament-and-disarmament/dual-use-and-arms-trade-control>



### Three Main Question Marks

- 1) Are the global value chains mainly belonging and managed simply by national shaping and political governance and/or dominance, or are they more and more resulting into transnational, sophisticated nets of specialized enterprises in closely partnership?
- 2) Are they competitive in dual high-tech sectors then mainly driven by the international markets, so irresistibly pushing toward a stage of industrial production and sectoral integration where is already more crucial and vital than the conditionality of the producing countries?
- 3) Looking to the “market” of defence dual-technologies, is the presence of a wide international trade of these technologies more and more guiding their own strategies and markets, in competition but in strategic partnerships even in the defence sector and much less conditionate national political or almost oligopolistic attitudes as in the past?

We have not to find answers straight now, but we need to keep permanently in mind these questions marks for the future, the near future, the daily management of production. I have myself only credible elements to forecast this scenario but no final answers today, as the fog at this stage is still dense and the experts are divided and silent on these issues. Let's start being more farsighted considering China defence sectors or Russia capabilities or the new entry of strategic players countries in the five continents.

Rumors of high tensions and instrumental media coverage of this “technological clash”, with a kind of tariffs trade war ignited by US and China in long lists of products - spreading unbalanced repercussions to their domestic economies and international markets as well - where you can recognize also the ones affecting all the high industrialized countries highering around the world highering dangerous stages a so called “trade war”, where antagonisms might result into an out of control situation. For sure, the good mood of G 20 Osaka conclusions have reduced temporarily the temperature but what's next? Even U.S. and Europe trade relations are in a light cloudy forecast as circulating voices of measures of U.S. related to Airbus, the leading civil aviation European industrial Group - by the way partner of top UK aerospace industries for avionics and of Rolls Royce for jet turbines - just because with A-320, A321, A350 the Toulouse based Group accumulated a wide market preference, trust and confidence among almost all international air carriers. As I will mention more than once, my experience and knowledge showed by and large how any tariffs leverage is effective among main, advanced economic powers in the medium-long run and EU is by and large the first trade dynamic ranking today. Europe in fact is the world's largest exporter of manufactured goods and services, and is itself the biggest export market for around 80 countries. Together, the European Union's members account (data released by Eurostat on May 2019) for almost 17% of world imports and exports<sup>16</sup>.

As straightforward researcher, I perceive the *conundrum* these data are posing but

<sup>16</sup> [http://trade.ec.europa.eu/doclib/docs/2013/december/tradoc\\_151969.pdf](http://trade.ec.europa.eu/doclib/docs/2013/december/tradoc_151969.pdf) ; <http://ec.europa.eu/trade/policy/eu-position-in-world-trade/>

at the same time the instrumentalization growing in the three main protagonist sides of this clash, U.S. China and European Union<sup>17</sup>. With Europe moving to a “third player mode” into the substance revealed by Huawei case and surrounding implications fostering the EU capabilities to enter in a positive competition way with the major players. We are now in fact are this turning point. And East Asian countries focusing on as well on the stability and governance in the region, with Japan, South Korea, Taiwan, Philippines, Viet Nam, Singapore, Indonesia and Malaysia highering their regional defence spending and capabilities.

Here is the divide we have to keep into care, as we assisted recently to trade tariffs disputes for segments of dual technological productions, specifically touching the core of AI and computing data and information management. We are learning more and more that any monopolistic policy will work at global scale, as the competitors might be more than several and nobody have to presume to be ahead of the others, for the basic principle that in an advance industrial world all technologies can be transformed into supply chain sectors, with a plurality of players and markets.

The answers are in fact tied to the evident growing differential, in these specific sectors, among economic systems, industrial productions organization, market development, civil and defence new generation extraordinary products. The sharp reality we had been assisting in the recent months is summarized by the preeminence of competitive open market drivers - to great extent even in the sectors and segments of the defence groups and industries - in an environment of a limited groups of competitive players, let say of the 70-80 industrial main groups sharing a relevant part of the global offer and market shares.

The openness and competitiveness are factors that can't be stopped easily regarding the so-called open market main economy long lasting players but might be the opportunity even in the specificity of China<sup>18</sup> peculiar system, structures and citizens perceptions, from one side, and of Russia heritage of the full economic collapsing system and still in progress toward a new one not yet fully achieved.

Political governance, in other words, can't be imagined as uniform and shared at the same tuning around the world, as in the superficial aims of a total globalization vision. International trade of technologies, final industrial productions, goods, energy and raw materials is of major, crucial relevance for all the countries, unions and alliances. To rise barriers with tariffs or within international organizations restrictions had often resulted into inconclusive tensions and even open conflicts.

Advanced weaponry transfers are under our eyes, as the ways to skip the classic tools of limitations or embargo in the procurements fields, for both civil and military sectors, show a parallel expertise of producer countries to find alternatives, even under the format of shadow and not visible registered forwarding, through a wide fan of tricks to circumvent sanctions or bans to official export channels, under complex or illegal deals and channels.

What to wait for the future? Difficult to say now. I then come back to my paper and

<sup>17</sup> [http://www.europarl.europa.eu/RegData/etudes/BRIE/2019/633149/EPRS\\_BRI\(2019\)633149\\_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/BRIE/2019/633149/EPRS_BRI(2019)633149_EN.pdf)

<sup>18</sup> <https://www.iiss.org/blogs/military-balance/2018/08/china-global-defence-industry-league>

leave these complex and frictional issues to the next future, assuming the classic Latin style .... “*et posteris iudices*”, meaning in the future, “posterity will judge”.

But one point might become a positive sign: there are growing premises for a “third horse” into the game between US and China clashing in fact around the highest technologies, web evolution, information tech advancing, AI and as we mentioned Quantum and Hypersonic vehicles. Since ever, competition had being resulting as an effective, good treatment of markets contagion, diseases and deviations, specifically when too much sharp duopolistic and protected markets are leading apparently not disturbed, as in fact they should foresight and perceive.

I quote the “Global digital leadership: A two horse races ?” from a document prepared by Kevin Koerner<sup>19</sup> for Deutsche Bank Research. “In the competition for global leadership in technologies like artificial intelligence, most observers see a two-horse race between China and the United States. But what about Europe? Can it ever catch up to the galloping favorites? It won’t be easy. The digital economy in the United States has big advantages: a large domestic market, a risk-taking investment culture, and plenty of innovative companies and world-class universities. US tech giants were first-movers out of the gates, and used the network effects of the platform economy to dominate not only the US, but many other markets worldwide”.

But scenario has changed in the last two decades and competition ramped on quickly. “Among the competitors, China had assumed the major role. I quote from the mentioned researcher paper: “One exception is China. Chinese policies like the “Great Firewall”, which limits foreign internet services, and basic state support for home-grown companies, have reined in US tech giants and given China a booming digital economy of its own. Their companies are now direct competitors with U.S. firms in the fields of artificial intelligence and robotics, as they jockey for market share and talent. Europe, meanwhile, had fallen behind. Despite its top wealth, qualified workforce and excellent research facilities, Europe still lacks its own competitive tech giants. It boasts the world’s second-largest market, but that market is fragmented. New policies that might help the bloc competing globally often falter due to divergent national interests. Venture capital and risk-taking entrepreneurial spirit are still harder to come by in Europe than across the Atlantic”.

“But Europe – conclude Koerner - has recently announced major investment packages and launched strategic initiatives like the AI Alliance, designed to get the continent back in the hunt. The continent has also pioneered new standards for regulation, data protection and competition. Whether this kind of regulation spurs or slows the data economy is yet to be seen. But in an era of data scandals and consumer insecurity, it is conceivable that “made-in-Europe” data protection -conclude the researcher of Deutsche Bank - could become a valuable brand for the third horse in the race”.

*(End quotation)*

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<sup>19</sup> [https://www.dbresearch.com/servlet/reweb2.ReWEB?rwnode=RPS\\_EN-PROD\\$INTERNAT&rwsite=RPS\\_EN-PROD&rwobj=ReDisplay.Start.class&document=PROD000000000489430](https://www.dbresearch.com/servlet/reweb2.ReWEB?rwnode=RPS_EN-PROD$INTERNAT&rwsite=RPS_EN-PROD&rwobj=ReDisplay.Start.class&document=PROD000000000489430)

The innovative scenario we stand in front of shows to be applicable *de facto* to European productions and output shares of the global industrial main sectors in almost all the sophisticated areas of production, within the highly competitive endowment of factors from cybernetics, avionics, cars and trucks productions, medical diagnostic technologies, space programs, **nanotechnologies**, life sciences, environmental emergencies, meteorology and oceans monitoring, medicine, health treatments, computing sciences, agriculture ecologic treatments, diffusion of industrial robotized factories, artificial intelligence, battery and hybrid cars and trucks, aerospace, telecommunications, radar and navigation enhanced systems directly induced from military aviation experiences, not to talk of computers and cellphones entered quickly as protagonist actors of the individual life in the five “connected” e-continent. Sorry for the long list that is very telling anyway of the status of the frictions.

### **A Step Ahead: the New Theories of Growth**

New theories of Growth, the so-called *revised* Solow applied models approaches, around 1990 gave a start to the third millennium, anticipating the forthcoming new basic factors deeply changing the past industrial system and introducing crucial key finally measurable variables directly affecting society, production, finance, governance, development and institutions. I feel quite appropriate to propose the original copy of the NBER Cambridge Massachusetts announcement of the master turning point in literature on growth “A Contribution to the Empirics of Economic Growth”, by three authors: David Romer<sup>20</sup>, Gregory Mankiw and David Weil.

#### NBER WORKING PAPERS SERIES

#### A CONTRIBUTION TO THE EMPIRICS OF ECONOMIC GROWTH 21

N. Gregory Mankiw  
David Romer  
David N. Weil  
Working Paper No. 3541

NATIONAL BUREAU OF ECONOMIC RESEARCH  
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We are grateful to Karen Dynan for research assistance, to Laurence Ball, Olivier Blanchard, Anne Case, Lawrence Katz, Robert King, Paul Romer, Xavier Sala—i—

<sup>20</sup> N. Gregory Mankiw, David Romer, David N. Weil; [https://eml.berkeley.edu/~dromer/papers/MRW\\_QJE1992.pdf](https://eml.berkeley.edu/~dromer/papers/MRW_QJE1992.pdf)

<sup>21</sup> NBER- National Bureau of Economic Research, USA

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## A CONTRIBUTION TO THE EMPIRICS OF ECONOMIC GROWTH ABSTRACT

This paper examines whether the Solow growth model is consistent with the international variation in the standard of living. It shows that an augmented Solow model that includes accumulation of human as well as physical capital provides an excellent description of the cross-country data. The model explains about 80 percent of the international variation in income per capita, and the estimated influences of physical-capital accumulation, human-capital accumulation, and population growth confirm the model's predictions. The paper also examines the implications of the Solow model for convergence in standards of living—that is, for whether poor countries tend to grow faster than rich countries. The evidence indicates that, holding population growth and capital accumulation constant, countries converge at about the rate the augmented Solow model predicts.

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Next step. Theories of Growth had in any case a decisive implementation from the Solow milestone with “A Contribution to the Empirics of Economic Growth”, in 1990, by three authors: David Romer, Gregory Mankiw and David Weil. The further developments of theories start in the 2000 to integrate and enlarge the focus - as for instance the one shown in “DBR-Global Growth Centres 2020” - are moving further on these assumptions. What was perceived as an intuition is in fact a reality with the complexity of new factors and variables to be integrated.

A detailed overview on the new perspectives had been offered in 2018 by Daniel

Gross, Director CEPS, Brussels, with “Global Trends to 2035 Economy and Society”<sup>22</sup> for the EPRS-European Parliamentary Research Service. In fact, Europe at large is representing the best world case and laboratory for a fair, shared sustainable future not only in dual-technologies enhancing and developments, as this paper is focusing, but in an overall horizon of variables and connected outcomes.

We have to connect these observations with the new brand economic theories of Growth developments, the so-called or *revised* Solow applied models approaches. The colleagues working actually on these “new theories” had already proposed more than eighty revisited or quite different approaches elaborations. Fantasy is now on power and seems to be very fertile.

When the new century 2000 gave a start to the third millennium, anticipating the forthcoming new basic factors deeply changing, also the theoretical approaches upgraded and penetrated into the news production and industrial system achievements, introducing crucial key finally measurable or good proxy variables directly affecting the industrial production, financial and social governance, technology impacts, education, health, long life expectancy, immigration explosion, immaterial values relevance. Specifically, the two complex variables “T” technology and “H” human capital.

In other words, the crucial GDP, the results in PPP per capita incomes, the clusters of many variables more measurable drivers around the world became more and more sophisticated and determinant. Scientific community and prominent scholars’ analyses are adding valuable, solid outcomes in a work still in progress, as we are talking of magmatic aspects of future researches.

Remarkable as before underlined was the contribution by N. Gregory Mankiw, David Romer<sup>23</sup> and David N. Weil with their “A contribution to the Empirics of Economic Growth, NBER Working Paper 3541, December 1990. But researching is a never-ending intellectual mission.

I am proposing now the relevant applied contribution of the Formel-G approach to the theories of Growth as in “Global growth centers 2020 Formel-G”, diffused in 2005 by Deutsche Bank Research, a main financial think tank leading the advanced forecast analyses. Here you find two pages from the DBR new Theories of Growth<sup>24</sup> analyses, outcomes and trends map.

Presenting my paper, I gave some quick references to the innovative clusters and drivers emerging from the blossoming of analytical theoretical and applied contributions in scholarly books, advanced researches, journals, faculty presentations and experts, all indispensable reading of the evident transition from the past to the future applied economic thinking.

To move a bit further, I had considered many of the best scientific contributions, researches, and main academic and institutional centers. Let us try to introduce the appropriate factors “K - H - P - A - L” of the 2005 Formel-G by DBR, as I just

<sup>22</sup> [http://www.europarl.europa.eu/RegData/etudes/STUD/2018/627126/EPRS\\_STU\(2018\)627126\\_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/STUD/2018/627126/EPRS_STU(2018)627126_EN.pdf)

<sup>23</sup> <https://www.nber.org/papers/w3541.pdf>

<sup>24</sup> DBR-new Theories of Growth analyses and outcomes

integrally proposed to your attention with the previous pages. These Growth “factors” and variables need to incorporate some further, evolutionary perspectives and strategic peculiarities at present and looking to future 2020-2030. “Dual Technologies Sectors Innovation and Growth: Civil and Military Industries in Europe versus US and China” is the main issue and we need to extend our economic, industrial and civil-defence productions as well as in researches related to high-tech and advanced financial implications. As is now evident, these issues are complex and “in progress” but not for this reason left in the fog and vague assumptions. From one side, assuming that factors H-human capital incorporating knowledge and related outcomes; A-technological as the unpredictable advancements request to be further investigated; and introducing the new aggregated variable P-governance policy, so much determinant for a contemporary competitive, open and value chains organized economic regional and transnational successful industrial system.

We are in front to the most important driver of change, to a magnitude that was perceived but even so unexpected so soon at this stage just twenty years ago, in 2000. History always showed that progress in research brings to different outcomes time passing; and this is the age of the fourth industrial revolution.

We are still on the move, with the impact of this immaterial variables, as the so debated “A” technologies exogenous new factor jumped into the stage. Although theory does not produce a clear conclusion on the “correct” growth model (the “correct” P), it helps to identify a potential fan of growth drivers.

The decision regarding to which additional variables really have a statistically and economically significant link with growth is an open debate and a quantitative advanced researching effort based on econometric analysis, following several schools of thinking. From my own experience, the main researching projects on the specific area of studies are moving on a base of almost one hundred variables-factors-data exanimated and included in the possible P over all composite weight.

## B. Theory and methodology

After the first results have been presented and the analytical framework has been outlined, the next two sections explain the fundamentals of modern theoretical and empirical growth analysis. An important element of *Formel-G* will be derived: the econometric equation.

### 4. Searching for technological progress

Growth forecasts must have a solid theoretical foundation. The basis of most growth analyses is the **neoclassical production function** in which **output Y** is a function of **labour input L**, **capital input K** and the **level of technology A** (Solow residual; usually called “total factor productivity”). Growth decompositions divide actual growth into these three components. However, over the long-term, the sole driver of any growth of per capita output is the progress of technology A. It also is crucial for the long-term increase in the capital stock per capita.<sup>10</sup> Therefore, forecasts of economic growth with the help of simple growth decompositions require more or less arbitrary assumptions on technological progress.<sup>11</sup> They do not explain the really interesting variable A but bury it in an assumption. Therefore, simple growth decompositions are not suitable for forecasting.

The often assumed **absolute convergence** of income levels between countries (i.e. poor countries' GDP grows faster than rich countries') also lacks theoretical and empirical support. There is no automatism: higher income levels do not fall from heaven like manna but require hard work.<sup>12</sup> GDP of a country only converges to the country-specific income level that is determined by that country's growth drivers.

Therefore, any useful model of the future has to explain technological progress. This is easier said than done, however. Mankiw/Romer/Weil made a pathbreaking contribution in 1992 by incorporating **human capital H** as a measure for the quality of labour input into the empirical growth analysis. Human capital describes a person's ability to produce output efficiently and to develop new products. This important additional variable helped significantly in explaining historic income differences across countries.

For empirical growth analysis, this was a great step forward but not fully satisfactory yet. Both theoretical and empirical work of the last ten years tried to model the remaining, unexplained share of technological change after human capital is taken into consideration. The objective is to **explain economic growth as fully as possible in the model** by incorporating a further policy variable P (or several variables). Exogenous, unexplainable influences are to be minimised.

The search for P gave rise to a flourishing literature dealing with the role of politics, institutions, knowledge and innovation.<sup>13</sup> In their overview, Durlauf, Johnson and Temple (2004) identify 42 “growth theories” using a total of 102 variables – which may be combined in different variations.<sup>14</sup> Although theory does not produce a clear conclusion on the “correct” growth model (the “correct” P) it helps us identify potential growth drivers. The decision as to which additional variables really have a statistically and economically significant link with growth will have to be based on econometric analysis.

**Theoretical foundation: the production function**

**Production function in the Solow model:**

$$Y_t = K_t^\alpha \cdot (A_t \cdot L_t)^{1-\alpha}$$

**Absolute convergence not a given**

**Production function in the Mankiw/Romer/Weil model:**

$$Y_t = K_t^\alpha \cdot H_t^\beta \cdot (\tilde{A}_t \cdot L_t)^{1-\alpha-\beta}$$

**Production function in *Formel-G*:**

$$Y_t = K_t^\alpha \cdot H_t^\beta \cdot (P_t \cdot \hat{A}_t \cdot L_t)^{1-\alpha-\beta}$$

<sup>10</sup> This is set out very clearly by Barro, Sala-i-Martin (2004), pp. 457 and 460.

<sup>11</sup> For example, filter techniques with averages of the past are applied or absolute convergence with other countries is assumed.

<sup>12</sup> Easterly and Levine (2001) even observe a divergence in income levels.

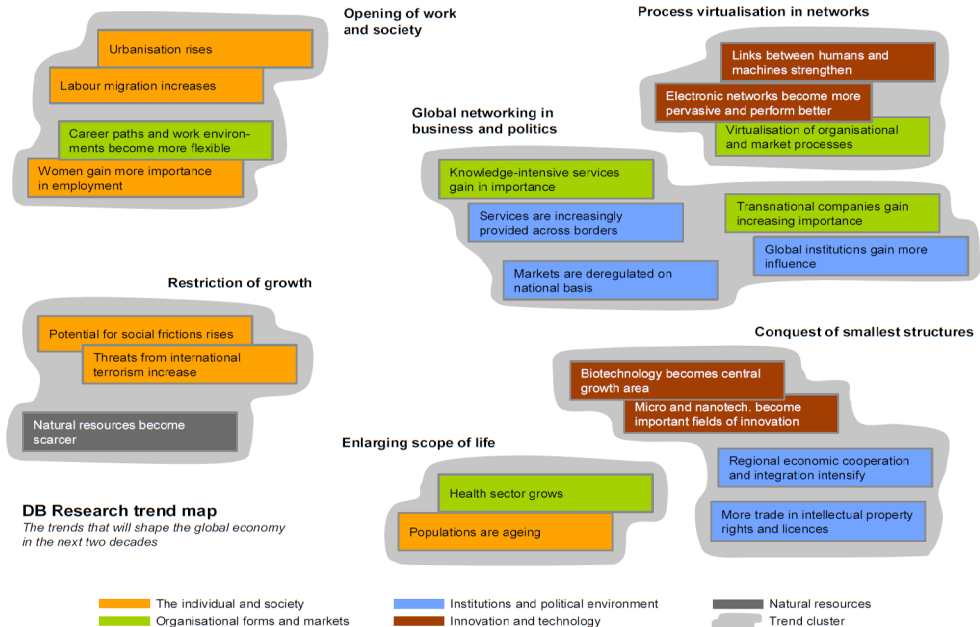
<sup>13</sup> The World Bank, the IMF, the OECD and the NBER have contributed many new insights with new data sets and a large number of publications.

<sup>14</sup> Temple (1999) also gives an excellent overview.



1. DBR's *Formel-G*

## Deutsche Bank Research's trend map



Presenting my paper, I give some quick references to the innovative clusters and drivers emerging from the blossoming of analytical theoretical and applied references in scholarly books, advanced researches, journals, faculty presentations and experts reading of the evident transition from the past and an evolutionary future applied economic thinking. The issues now presented are in fact very much binding the main protagonists of the international relations. And first of all of the policy choices and governance implications that that can't be shadowed or underestimated as these advancements and driver of development, competitiveness, wealth or underdevelopment, raw materials, new discoveries and strategic choices are directly affecting the security options.

In fact, scientific schools of thinking are existing for the really purpose to test and find flaws in the other field of theoretical approach. At the end to create a scientific competition among theories and applied policies, institutions and governance.

One of these scholars is Justin Yifu Lin Lin, a leading Chinese economist who served as chief economist to the World Bank in 2008-2012. So Lin has a deep level of knowledge and the experiences of developing countries and their efforts to achieve sustained growth. He believes that the answer to the question posed above is "yes", and he lays out the central components of such a policy in a framework that he describes

as the “new structural economics”. His analysis is presented in *New Structural Economics: A Framework for Rethinking Development and Policy*<sup>25</sup>. Lin’s analysis is intended to be relevant for all low- and middle-income countries (e.g. Brazil, Nigeria, or Indonesia); but the primary application was China. So his question comes down to this: what steps does the Chinese state need to take to burst out of the “middle income trap” and bring per capita incomes in the country up to the level of high-income countries in the OECD?

What are the core premises of Lin’s analysis of sustainable economic growth? Two are most basic: the market should govern prices, and the state should make intelligent policies and investments that encourage the “right kind” of innovation in economic activity in the country. Recently he entered the touchy issue of the “Trade War” U.S. vs. China. “If the United States maintains its trade war with China it will miss out on the benefits of the Asian nation’s future growth”<sup>26</sup>. Unlike other emerging economies like Russia, India, Brazil and Turkey, China has good investment opportunities to realize its growth potential, said Justin Lin Yifu, who is also a senior professor at Peking University. “And if the U.S. misses out on those opportunities, they will be snapped up by other players, like Japan, South Korea and the European Union”, he said.

The main military actors nowadays as European Union, China and Russia - in the frame of their historical national formats, alliances or in the new geopolitical scenario of bilateral and multilateral developments continuously in progress - had pushed into a growing competition both the long-running military and transnational political institutions, such as NATO or other multilateral forms of strategic and operational agreements, and even more by individual player countries growing roles, as the case I mention again of France, Germany, UK, Italy, Spain Sweden and Switzerland as well as India, Israel, Japan, South Korea, Taiwan, Malaysia, Brunei, Philippines as well as Singapore, Viet Nam, Thailand, Pakistan, Saudi Arabia, Turkey, Egypt even if we have not to neglect main players as Brazil, Chile, Mexico, Australia and New Zealand just to mention and showing them in evidence, with an open list for future incoming players: rising Central Asians countries, Middle East and of course the Baltic, Central and Eastern European ones that at large will make the difference in the future.

### **From Conventional to Nuclear then into Future**

Enlarging the horizon, even in the frame related to nuclear weapons, had been recently reshaped. Until a possible renegotiation of the INF Treaty (Intermediate range Nuclear Forces, then from 500 to 5,000 kilometers in radius) - after the USA decision to withdraw from this nuclear arms treaty signed in 1987 with Russia and the diffuse perceptions and rumors, in Europe and among the major military powers, that Russia was violating systematically the Treaty - the push for modernization and technologic

<sup>25</sup> Justin Yifu Lin, Beijing University, *New Structural Economics A Framework for Rethinking Development* (WB); [https://www.bancaditalia.it/pubblicazioni/altri-atti-seminari/2011/paper\\_lin\\_economics.pdf](https://www.bancaditalia.it/pubblicazioni/altri-atti-seminari/2011/paper_lin_economics.pdf)

<sup>26</sup> <https://www.scmp.com/economy/china-economy/article/2171295/end-trade-war-china-or-miss-out-future-growth-ex-world-bank>

upgrade deterrence restart, as mini nuclear weapons that are on the stage now. Just for to recall this not well debated point, INF was in any case the unique arms control agreement banning a full class of strategic weapons both for Russia and the US, a key acquisition of the post URSS détente.

It must be distinguished of course INF from the CNTB-Comprehensive Nuclear Test Ban Treaty, this last one signed in 1996 but after not ratified by U.S. and other relevant countries as China, Egypt, Israel, Iran and Yemen jst to mention. But an even not perfect INF should be better, in this transition time from mass destructions old technologies - frequently defined properly as “holocaust” both in intellectual and effective humanity tragedy results - to new incoming last generation much more flexible, focused and targeted scenario. Completely new arsenals of high technologies had quickly substituted the previous generations, as mainly shown in the regional wars, terrorism, insurgencies not to talk of movies, tv series, romances and a kind of unforgettable nightmare in the past. In good or worst, in peace or epic war, with a human toll of dozens of millions lives lost and horrible ethnic or religious genocides, dramas for soldiers and civils victims, until peace and reconciliations arriving so late and in contradictory, compromised situation on the field. But nothing so striking as the future is announcing. Almost all the main scientific turning point applications must be driven in fact to be conquest for humanity not for the dissolution of the human beings.

If we looking ahead to perspective ten, twenty years, with the extraordinary potentiality and application scenario of Quantum information computer system, with data and operational information capabilities, at the “light” speed performance of 300.000 kilometers per second, the rise of a new geopolitical world has already start. Even Einstein would be amazed. Not to forget, in recent years, another new development with a strong impact on previous technologies, the mentioned hypersonic vehicles.

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The room had been in this way left open for the development of the PrSM-Precision Strike Missile, in anticipation of the future integration and announced operational deployment of hypersonic jets, missiles, vehicles, devices with the forthcoming quantum value added in terms of universal implications.

But in fact these tensions are destined to be domed in the medium term by the negative impact on GDP and real growth for all the countries leading this confrontation, a part the looming of international tensions and incumbent war scenarios. The more qualified economics theories and applied researches had mainly demonstrated as in the past two centuries how these conflictual outcomes of similar policies brought to antagonism and mutual wars, implying horrible human life pay tolls. While the past had not available any weapons of humanity destroying capabilities- then war was

a last but possible option - today and even more tomorrow the looming of terrific conflicts will have a substance and a threatening conditionality.

As it had been has already been announced - or let been understood by the international community and specifically Russia, U.S. and China as well as *de facto* European Union and Asian key countries - the testing of missiles, rockets, jets and vehicles in the atmosphere and stratosphere with speeds up to ten times the sound speed had been successful. The Hypersonic Glide Vehicles, as jets and missiles with speed capacity up to match 10 match and even more - therefore with performances in the range of 10,000/20,000 km/h in atmospheric and stratospheric missions - are radically changing the balance of strength and defence capabilities built and developed until now<sup>27</sup>. Already the counter move has been already activated<sup>28</sup>. “DARPA-Defense Advanced Research Projects Agency - I mention with passion as I love to reading history - had been founded by Dwight David Eisenhower President of US and army general and statesman - calls it “counter-hypersonic”. The rest of U.S. would call it a way to stop nuclear warheads coming down at 20 times the speed of sound. DARPA, the Pentagon’s research agency, wants an interceptor that can stop weapons that are hypersonic (travel faster than Mach 5. The agency has begun soliciting proposals for glide breaker, its project to stop boost-glide vehicles that are lofted high into the atmosphere atop a ballistic missile, and then glide down to Earth. The current exemplar is Russia’s Avangard, touted by President Vladimir Putin as unstoppable by anti-missile defenses. But China and the U.S. are also developing boost-glide vehicles. The fan of aspects on defence and security impact in the civil-military industrial sectors and the international players companies and groups sharing great part of international trade are showing how high technologies are progressively integrated into an increasingly convergent, sophisticated indivisible systems. A perspective that will induce relevant advancements to the development of further scientific and operational applications on the forefront of production related to crucial areas of the defence systems and the unstoppable new implementations through the forthcoming discoveries and scientific advancements. Let us take for instance the tech of the no-nuclear powers producing the most advanced equipment, X-rays equipment, medical and industrial engineering in the civil use of nuclear applications and the existing wide energy production, then environment but how to forget the application of informative system in any professional entity and now even with domestic valuable relevance.

As before stated, we are in front of one of the most sophisticated and global industrial value chain productions ever existing, with competitors and countries also in exercises of old fashion but never abandoned trade and tariffs conflicts.

Here we might focus in recent clashes among main powers and alliances systems regarding telecommunications, digitalization processes, computing, social networks, privacy and patents urgent protection quests of a better governance for all citizens, companies and financial systems rights, in other words the data

<sup>27</sup> <https://www.strategyand.pwc.com/trend/2019-aerospace-defence>

<sup>28</sup> <https://nationalinterest.org/blog/buzz/meet-darpas-glide-breaker-hypersonic-missile-killer-42117>

protection next clash of civilization. The mission of the great powers must be then to avoiding unpredictable wars and to find the possible realistic solutions to any trade unbalancing divide, through negotiation, diplomatic solutions and appeasement. Nobody will force anybody in the future geopolitical scenario and in international relations disputes, this is a first conclusion of this paper.

Not for virtues but to avoid the following fatal retaliation with the same high-tech weapons. It's an unavoidable forecast but even a rejection heritage we European and Asians got from wrong policies of the dark past. We must in fact consider the European Union a very advanced and competitive industrial value chain in all the leading sectors of defense and security, capable already to compete globally. In fact, the EU and its most advanced countries have achieved a degree of competitiveness and standing that is now reflected in the official documents and programs moving rapidly towards these goals.

### **Institutional Determinants of Military Spending and Growth Implications**

Daniel Albalade<sup>29</sup> and Germà Bel and Ferran Elias, from the University of Barcelona, elaborated a research published by Springer on Institutional Determinants of Military Spending. "Drawing on a database for 1988-2006 containing information on 157 countries, we investigate the effects on military spending of government form and democracy, electoral rules and concentration of parliamentary parties. From an OLS regression on pooled data, our results show that presidential democracies spend more than parliamentary systems on defense, whereas its interaction with a majoritarian electoral rule reduces the defense burden. Our findings suggest that, in contrast to theoretical predictions in the literature, institutions do not have the same impact on the provision of all public goods". This means, in other words, that political systems have great roles in the public good choices, depending their structure and decision-making process. Representative democracies then are less incline to support highering military expenditures while other autocratic institutions and governments - both if not elective parliament system or because constitutionally presidential political systems - are more following the requests of military building up. But this approach to splitting in two several institutional systems remains very volatile and is not generally speaking giving a robust decisive research support. In this case the regression on pooled data didn't give the expected indications. The same happens with the impact of defence spending on growth. It's evident that in a robust dual-technology environment the distance between the results of public spending on civil and military in terms of return over investments is the decisive factor but the econometric evidence is not generally speaking giving a decisive support. Reading the results available, as in "Military Expenditure, Investment and Growth" by John Paul Dunne <sup>30</sup> there are not new achievements, even if the research is absolutely valuable. I quote his book: "This research considers the issues involved in estimating the effect of military expenditure on growth and the reasons

<sup>29</sup> <https://www.sciencedirect.com/science/article/pii/S0147596711000758>

<sup>30</sup> <https://www.tandfonline.com/action/showCitFormats?doi=10.1080%2F10242694.2019.1636182>

for the lack of consensus in the literature. It briefly reviews the economic theory, emphasizing the difficult identification issues involved in determining the interaction between military expenditure and output and discusses econometric methods for panels. It then takes advantage of the extended SIPRI military spending to construct a relatively large balanced panel of countries for the period 1960–2014.

Rather than the usual focus on the direct relation between military spending on growth, it focusses upon the investment channel. It provides estimates of various models examining the interaction between the three variables and finds that the data do not suggest any strong relations between military expenditure and either investment or growth. This is not unexpected given the theoretical and econometric problems identified<sup>31</sup>. This paper intends to focus on issues and conditionalities of strategic and technological factors top relevance for national economies, in presence of highly tech based defence systems and military capabilities in progress, with the robust upgrade both referring to triptych of main military powers before mentioned but also considering the valuable contribution of the European leading industrial high standards sectors in a growing international openness.

I will also comment on the recent findings and reports of the IISS-International Institute for Strategic Studies in London and the SIPRI before mentioned on the main developments and trends in the defence industrial sectors analysed throughout 2018, with particular reference to the challenges on the control of nuclear weapons and in the cyber war sector, with a focus on Quantum and its extraordinary potential in the fields of Defence and in our citizen life and cyber security.

The data will also offer the opportunity to measure an indicative size of the relative civil/military output of the main industrial groups or consortiums worldwide. Starting this year, also China data of the military industrial sectors start to be included into the SIPRI and IISS dataset<sup>31</sup>.

The data by SIPRI-Stockholm International Peace Research Institute, the authoritative Swedish Institute in the field of military spending of world governments in armaments, in fact demonstrates a progressive expansion of orders and technological cooperation among European industrial groups. Italy as well has an important international technological and production role, ranking at the nine position in the all world countries scale, with industrial groups that have taken leading positions in the main sectors of military production and in the export of weapons systems, often in cooperation with European<sup>32</sup> and U.S. partners. Global defence spending in 2018 was at record high: 4 charts that show where the money goes<sup>33</sup>. SIPRI jointly with World Economic Forum issued a Report 2018 to alert all of us that Global defence spending is at a record recent history high<sup>34</sup>.

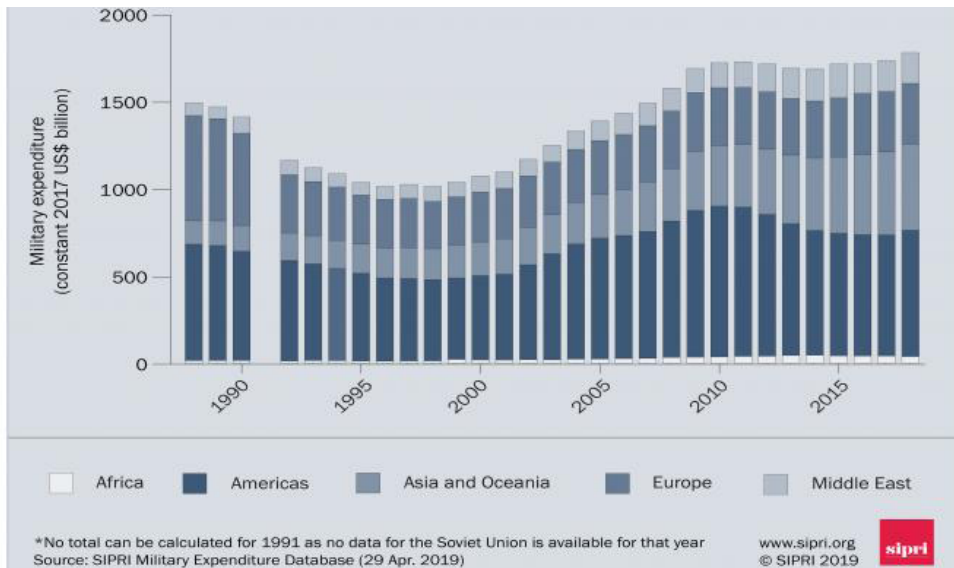
<sup>31</sup> [https://www.sipri.org/sites/default/files/2019-04/fs\\_1904\\_milex\\_2018.pdf](https://www.sipri.org/sites/default/files/2019-04/fs_1904_milex_2018.pdf)

<sup>32</sup> <https://www.eda.europa.eu/info-hub/publications/publication-details/pub/annual-report-2018>

<sup>33</sup> <https://www.weforum.org/agenda/2019/04/4-charts-that-show-the-state-of-global-military-spending-now-at-its-highest-since-the-cold-war/>

<sup>34</sup> [https://www.sipri.org/sites/default/files/2019-04/fs\\_1904\\_milex\\_2018.pdf](https://www.sipri.org/sites/default/files/2019-04/fs_1904_milex_2018.pdf);

## World military expenditure grows to \$1.8 trillion in 2018<sup>35</sup>



World military spending 1988–2018. Data and graphic: SIPRI 29 April 2019

Total world military expenditure rose to \$1822 billion in 2018, representing an increase of 2.6 per cent from 2017, according to new data from the Stockholm International Peace Research Institute (SIPRI). The five biggest spenders in 2018 were the United States, China, Saudi Arabia, India and France, which together accounted for 60 per cent of global military spending. Military spending by the USA increased for the first time since 2010, while spending by China grew for the 24th consecutive year. The comprehensive annual update of the SIPRI Military Expenditure Database is accessible from today at [www.sipri.org](http://www.sipri.org).

Total global military spending rose for the second consecutive year in 2018, to the highest level since 1988—the first year for which consistent global data is available. World spending is now 76 per cent higher than the post-cold war low in 1998.\* World military spending in 2018 represented 2.1 per cent of global gross domestic product (GDP) or \$239 per person. ‘In 2018 the USA and China accounted for half of the world’s military spending,’ says Dr Nan Tian, a researcher with the SIPRI Arms and Military Expenditure (AMEX) programme. ‘The higher level of world military expenditure in 2018 is mainly the result of significant increases in spending by these two countries.’

### The USA and China lead increase in world military expenditure

US military spending grew—for the first time since 2010—by 4.6 per cent, to reach \$649 billion in 2018. The USA remained by far the largest spender in the world, and spent almost as much on its military in 2018 as the next eight largest-spending

<sup>35</sup> <https://www.sipri.org/media/press-release/2019/world-military-expenditure-grows-18-trillion-2018>

countries combined. ‘The increase in US spending was driven by the implementation from 2017 of new arms procurement programmes under the Trump administration,’ says Dr Aude Fleurant, the director of the SIPRI AMEX programme. China, the second-largest spender in the world, increased its military expenditure by 5.0 per cent to \$250 billion in 2018. This was the 24th consecutive year of increase in Chinese military expenditure. Its spending in 2018 was almost 10 times higher than in 1994, and accounted for 14 per cent of world military spending. ‘Growth in Chinese military spending tracks the country’s overall economic growth,’ says Tian. ‘China has allocated 1.9 per cent of its GDP to the military every year since 2013.’

### **Three decades of growth in military spending in Asia and Oceania**

Military expenditure in Asia and Oceania has risen every year since 1988. At \$507 billion, military spending in the region accounted for 28 per cent of the global total in 2018, compared with just 9.0 per cent in 1988. In 2018 India increased its military spending by 3.1 per cent to \$66.5 billion. Military expenditure by Pakistan grew by 11 per cent (the same level of growth as in 2017), to reach \$11.4 billion in 2018. South Korean military expenditure was \$43.1 billion in 2018—an increase of 5.1 per cent compared with 2017 and the highest annual increase since 2005.

‘The tensions between countries in Asia as well as between China and the USA are major drivers for the continuing growth of military spending in the region,’ says Siemon Wezeman, a senior researcher with the SIPRI AMEX programme.

### **Increases in Central and East European countries**

Several countries in Central and Eastern Europe made large increases in their military expenditure in 2018. Spending by Poland rose by 8.9 per cent in 2018 to \$11.6 billion, while Ukraine’s spending was up by 21 per cent to \$4.8 billion. Spending by Bulgaria, Latvia, Lithuania and Romania also grew (ranging from 18 per cent to 24 per cent) in 2018. ‘The increases in Central and Eastern Europe are largely due to growing perceptions of a threat from Russia,’ said Pieter Wezeman, a senior researcher with the SIPRI AMEX programme. ‘This is despite the fact that Russian military spending has fallen for the past two years.’

At \$61.4 billion, Russian military spending was the sixth highest in the world in 2018. Its spending decreased by 3.5 per cent compared with 2017.

### **Other notable developments**

Military spending in South America rose by 3.1 per cent in 2018. This was mainly due to the increase in Brazilian spending (by 5.1 per cent), the second increase in as many years. Military expenditure in Africa fell by 8.4 per cent in 2018, the fourth consecutive annual decrease since the peak in spending in 2014. There were major decreases in spending by Algeria (–6.1 per cent), Angola (–18 per cent) and Sudan (–49 per cent). Military spending by states in the Middle East for which data is available fell by



1.9 per cent in 2018.

Total military expenditure by all 29 North Atlantic Treaty Organization members was \$963 billion in 2018, which accounted for 53 per cent of world spending. The largest absolute increase in spending in 2018 was by the USA (\$27.8 billion), while the biggest decrease was by Saudi Arabia (-\$4.6 billion).

Military spending in Turkey increased by 24 per cent in 2018 to \$19.0 billion, the highest annual percentage increase among the world's top 15 military spenders.

Six of the 10 countries with the highest military burden (military spending as a proportion of GDP) in the world in 2018 are in the Middle East: Saudi Arabia (8.8 per cent of GDP), Oman (8.2 per cent), Kuwait (5.1 per cent), Lebanon (5.0 per cent), Jordan (4.7 per cent) and Israel (4.3 per cent).

\* All percentage changes are expressed in real terms (constant 2017 prices).



**Table 1.** The 40 countries with the highest military expenditure in 2018  
Spending figures and GDP are in US\$, at current prices and exchange rates. Changes are in real terms, based on constant (2017) US\$. Percentages below 10 are rounded to 1 decimal place; those over 10 are rounded to whole numbers. Figures and percentage shares may not add up to stated totals or subtotals due to the conventions of rounding.

Rank	Rank		Country	Spending (\$ b), 2018	Change (%), 2009-18	Spending as a share of GDP (%) <sup>b</sup>		World share (%), 2018
	2018	2017 <sup>a</sup>				2018	2009	
1	1		United States	649	-17	3.2	4.6	36
2	2		China	[250]	83	[1.9]	[2.1]	[1.4]
3	3		Saudi Arabia	[67.6]	28	[8.8]	9.6	[3.7]
4	5		India	66.5	29	2.4	2.9	3.7
5	6		France	63.8	1.6	2.3	2.5	3.5
<b>Subtotal top 5</b>				<b>1 097</b>	..	..	..	<b>60</b>
6	4		Russia	61.4	27	3.9	3.9	3.4
7	7		United Kingdom	50.0	-17	1.8	2.4	2.7
8	9		Germany	49.5	9.0	1.2	1.4	2.7
9	8		Japan	46.6	2.3	0.9	1.0	2.6
10	10		South Korea	43.1	28	2.6	2.7	2.4
<b>Subtotal top 10</b>				<b>1 347</b>	..	..	..	<b>74</b>
11	13		Italy	27.8	-14	1.3	1.6	1.5
12	11		Brazil	27.8	17	1.5	1.5	1.5
13	12		Australia	26.7	21	1.9	1.9	1.5
14	14		Canada	21.6	12	1.3	1.4	1.2
15	15		Turkey	19.0	65	2.5	2.5	1.0
<b>Subtotal top 15</b>				<b>1 470</b>	..	..	..	<b>81</b>
16	16		Spain	18.2	-5.2	1.3	1.3	1.0
17	17		Israel	15.9	-5.8	4.3	6.8	0.9
18	18		Iran	13.2	-10	2.7	3.2	0.7
19	24		Poland	11.6	48	2.0	1.8	0.6
20	19		Pakistan	11.4	73	4.0	3.3	0.6
21	25		Netherlands	11.2	-4.4	1.2	1.4	0.6
22	21		Singapore	10.8	13	3.1	3.9	0.6
23	20		Taiwan	10.7	-2.9	1.8	2.3	0.6
24	23		Colombia	10.6	15	3.2	3.9	0.6
25	22		Algeria	9.6	85	5.3	3.8	0.5
26	26		Indonesia	7.4	99	0.7	0.6	0.4
27	29		Kuwait	7.3	39	5.1	4.0	0.4
28	30		Norway	7.1	23	1.6	1.6	0.4
29	31		Thailand	6.8	16	1.3	1.8	0.4
30	28		Oman	[6.7]	69	[8.2]	[7.0]	[0.4]
31	32		Mexico	6.6	36	0.5	0.5	0.4
32	27		Iraq	6.3	58	2.7	2.9	0.3
33	33		Sweden	5.8	18	1.0	1.2	0.3
34	35		Chile	5.6	25	1.9	2.3	0.3
35	37		Viet Nam	5.5	76	2.3	2.3	0.3
36	36		Greece	5.2	-46	2.4	3.2	0.3
37	39		Belgium	5.0	-12	0.9	1.2	0.3
38	38		Switzerland	4.8	6.3	0.7	0.7	0.3
39	43		Ukraine	4.8	69	3.8	[2.8]	0.3
40	46		Romania	4.6	112	1.9	1.3	0.3
<b>Subtotal top 40</b>				<b>1 683</b>	..	..	..	<b>93</b>
<b>World</b>				<b>1 822</b>	<b>5.4</b>	<b>2.1</b>	<b>2.6</b>	<b>100</b>

.. = data not available or not applicable; [] = SIPRI estimate; GDP = gross domestic product.

<sup>a</sup> Rankings for 2017 are based on updated military expenditure figures in the current edition of the SIPRI Military Expenditure Database. They may therefore differ from the rankings for 2017 given in *SIPRI Yearbook 2018* and in other SIPRI publications in 2018.

<sup>b</sup> The figures for military expenditure as a share of GDP are based on estimates of 2018 GDP from the International Monetary Fund World Economic Outlook and International Financial Statistics databases.

Sources: SIPRI Military Expenditure Database, Apr. 2019; International Monetary Fund, World Economic Outlook Database, Oct. 2018; and International Monetary Fund, International Financial Statistics Database, Sep. 2018.



### Annex 1. The SIPRI Top 100 arms-producing and military services companies in the world excluding China, 2017<sup>d</sup>

Figures for arms sales and total sales are in millions of US dollars.

Rank <sup>b</sup>		Company <sup>c</sup>	Country	Arms	Arms	Change in	Total	Arms
2017	2016			sales, 2017 (US\$ m.)	sales, 2016 (constant 2017 US\$ m.) <sup>d</sup>	arms sales, 2016–17 (%)	sales, 2017 (US\$ m.)	sales as a % of total sales, 2017
1	1	Lockheed Martin Corp.	United States	44 920	41 486	8.3	51 048	88
2	2	Boeing	United States	26 930	30 132	-11	93 392	29
3	3	Raytheon	United States	23 870	23 393	2.0	25 348	94
4	4	BAE Systems	United Kingdom	22 940	22 208	3.3	23 490	98
5	5	Northrop Grumman Corp.	United States	22 370	21 851	2.4	25 803	87
6	6	General Dynamics Corp.	United States	19 460	19 635	-0.9	30 973	63
7	7	Airbus Group	Trans-European <sup>e</sup>	11 290	12 928	-13	75 239	15
8	9	Thales	France	9 000	8 420	6.9	17 799	51
9	8	Leonardo	Italy	8 860	8 781	0.9	12 990	68
10	13	Almaz-Antey	Russia	8 570	7 320	17	9 122	94
11	11	United Technologies Corp.	United States	7 780	7 015	11	59 837	13
12	10	L-3 Communications	United States	7 750	7 791	-0.5	9 753	79
13	12	Huntington Ingalls Industries	United States	6 470	6 862	-5.7	7 441	87
14	14	United Aircraft Corp.	Russia	6 440	6 182	4.2	7 744	83
15	19	United Shipbuilding Corp.	Russia	4 980	4 864	2.4	5 583	89
16	22	Honeywell International	United States	4 460	3 553	26	40 534	11
17	16	Rolls-Royce	United Kingdom	4 420	4 336	1.9	19 346	23
18	17	Leidos	United States	4 380	4 391	-0.2	10 170	43
19	23	Naval Group	France	4 130	3 586	15	4 167	99
20	15	Textron	United States	4 100	4 860	-16	14 198	29
21	20	Booz Allen Hamilton	United States	4 060	4 084	-0.6	5 804	70
22	36	General Electric	United States	3 830	2 532	51	122 100	3
23	35	Tactical Missiles Corp.	Russia	3 600	3 031	19	3 623	99
24	21	Mitsubishi Heavy Industries	Japan	3 570	3 573	-0.1	36 649	10
25	25	Rheinmetall	Germany	3 420	3 373	1.4	6 644	51
26	26	MBDA	Trans-European <sup>e</sup>	3 380	3 346	1.0	3 501	97
27	24	Babcock International Group	United Kingdom	3 230	3 294	-1.9	6 876	47
28	27	Elbit Systems	Israel	3 220	3 313	-2.8	3 395	95
29	32	Russian Helicopters	Russia	3 170	3 139	1.0	3 908	81
30	29	Bechtel Corp. <sup>f</sup>	United States	3 150	2 879	9.4	25 900	12
31	18	Harris Corp.	United States	3 040	4 288	-29	6 182	49
32	28	CACI International	United States	2 980	2 890	3.1	4 468	67
33	34	Safran	France	2 910	2 679	8.6	19 090	15
34	46	High Precision Systems	Russia	2 830	2 324	22	2 907	97
35	31	Science Applications International Corp.	United States	2 760	2 685	2.8	4 454	62
36	30	Saab	Sweden	2 670	2 818	-5.3	3 180	84
37	38	Indian Ordnance Factories	India	2 650	2 442	8.5	2 764	96
38	37	Hindustan Aeronautics	India	2 610	2 635	-0.9	2 764	94
39	39	CSRA	United States	2 580	2 297	12	5 400	48
40	51	United Engine Corp.	Russia	2 570	2 049	25	4 026	64
41	33	Israel Aerospace Industries	Israel	2 480	2 790	-11	3 538	70
42	47	Orbital ATK	United States	2 390	1 960	22	4 764	50

Rank <sup>b</sup>		Company <sup>c</sup>	Country	Arms	Arms	Change in	Total	Arms
2017	2016			sales, 2017	sales, 2016	arms sales,		
				(US\$ m.)	(constant	2016-17	(US\$ m.)	% of total
					2017 US\$ m.) <sup>d</sup>	(%)		sales, 2017
43	41	Rockwell Collins	United States	2 300	2 277	1.0	6 822	34
44	48	General Atomics <sup>f</sup>	United States	2 220	1 950	14	..	..
45	45	Rafael	Israel	2 210	2 127	3.9	2 258	98
46	44	CEA	France	2 170	2 082	4.2	5 640	39
47	-	Russian Electronics <sup>g</sup>	Russia	2 140	1 894	13	3 771	57
48	42	Kawasaki Heavy Industries	Japan	2 140	2 112	1.3	14 035	15
49	40	Hanwha Techwin	South Korea	2 130	2 354	-9.5	3 729	57
50	61	Dassault Aviation Groupe	France	2 120	1 432	48	5 418	39
51	43	AECOM	United States	2 070	2 165	-4.4	18 203	11
52	54	KRET	Russia	2 060	1 929	6.8	2 398	86
53	49	ThyssenKrupp	Germany	1 920	1 831	4.8	46 706	4
54	64	Oshkosh Corp.	United States	1 840	1 378	33	6 830	27
55	78	KBR	United States	1 750	1 113	57	4 171	42
56	80	Krauss-Maffei Wegmann	Germany	1 750	1 086	61	1 803	97
57	52	ST Engineering	Singapore	1 680	1 706	-1.5	4 794	35
58	55	Fincantieri	Italy	1 660	1 653	0.4	5 657	29
59	58	Cobham	United Kingdom	1 580	1 510	4.6	2 632	60
60	56	LIG Nex1	South Korea	1 560	1 674	-6.8	1 558	100
61	68	ASELSAN	Turkey	1 420	1 101	29	1 469	97
62	65	DynCorp International	United States	1 420	1 307	8.6	2 004	71
63	67	GKN	United Kingdom	1 410	1 179	20	13 345	11
64	74	Bharat Electronics	India	1 380	1 232	12	1 616	86
65	60	ManTech International Corp.	United States	1 360	1 491	-8.8	1 717	79
66	53	UralVagonZavod	Russia	1 340	2 013	-33	2 223	60
67	63	Engility	United States	1 300	1 378	-5.7	1 932	67
68	66	BWX Technologies	United States	1 300	1 276	1.9	1 688	77
69	59	Serco	United Kingdom	1 250	1 462	-14	4 244	29
70	77	Turkish Aerospace Industries	Turkey	1 220	1 028	19	1 420	86
71	73	Aerojet Rocketdyne	United States	1 220	1 205	1.3	1 877	65
72	82	TransDigm Group	United States	1 190	970	23	3 504	34
73	76	PGZ	Poland	1 190	1 212	-1.8	1 323	90
74	-	Hensoldt <sup>h</sup>	Germany	1 160	1 200	-3.3	1 217	95
75	92	Vencore	United States	1 130	878	29	1 372	83
76	71	Vectrus	United States	1 120	1 215	-7.8	1 115	100
77	75	Fujitsu	Japan	1 110	1 119	-0.8	36 539	3
78	70	IHI Corp.	Japan	1 070	1 158	-7.6	14 175	8
79	88	Sierra Nevada Corp. <sup>f</sup>	United States	1 020	919	11	1 600	64
80	83	Austal	Australia	1 020	999	2.1	1 067	96
81	79	UkrOboronProm	Ukraine	1 020	1 148	-11	1 053	96
82	-	DXC <sup>i</sup>	United States	1 000	1 021	-2.1	24 556	4
83	87	Nexter	France	960	938	2.4	1 014	95
84	85	Embraer	Brazil	950	1 055	-10	5 821	16
85	72	DSME	South Korea	940	1 245	-25	9 821	10
86	86	Teledyne Technologies	United States	920	929	-1.0	2 604	35
87	108	Navantia	Spain	910	738	23	976	93
88	81	Jacobs Engineering Group	United States	900	1 011	-11	10 022	9
89	89	Precision Castparts Corp.	United States	900	899	0.2	9 003	10



Rank <sup>b</sup>		Company <sup>c</sup>	Country	Arms sales, 2017	Arms sales, 2016	Change in	Total	Arms
2017	2016			(US\$ m.)	(constant 2017 US\$ m.) <sup>d</sup>	arms sales, 2016–17 (%)	sales, 2017 (US\$ m.)	sales as a % of total sales, 2017
90	90	Cubic Corp.	United States	890	899	-1.0	1 486	60
91	98	Curtiss-Wright Corp.	United States	890	807	10	2 271	39
92	91	The Aerospace Corp.	United States	890	888	0.2	973	91
93	84	Meggitt	United Kingdom	880	916	-3.9	2 599	34
94	106	Bharat Dynamics	India	880	782	13	877	100
95	96	RUAG	Switzerland	870	824	5.6	1 985	44
96	102	MIT	United States	870	786	11	1 015	86
97	94	Moog	United States	860	847	1.5	2 498	35
98	50	Korea Aerospace Industries	South Korea	860	1 842	-53	1 833	47
99	97	NEC Corp.	Japan	850	789	7.8	..	..
100	99	CAE	Canada	840	809	3.8	2 181	38

.. = data not available; Corp. = Corporation.

<sup>a</sup> Although several Chinese arms-producing companies are large enough to rank among the SIPRI Top 100, it has not been possible to include them because of a lack of comparable and sufficiently accurate data for more than 3 years for some companies and no information at all for others.

<sup>b</sup> Companies are ranked according to the value of their arms sales at the end of what SIPRI considers to be their financial year. A dash (-) indicates that the company did not rank among the Top 100 for 2016. Company names and structures are listed as they were at the end of their financial year. Information about subsequent changes is provided in these notes. Rankings for 2016 are based on the updated arms-production figures. They may differ from those published in any earlier SIPRI publication and elsewhere owing to continual revision of data, most often because of changes reported by the company itself and sometimes because of improved estimations. Major revisions are explained in these notes.

<sup>c</sup> Holding and investment companies with no direct operational activities are not treated as arms-producing companies, and companies owned by them are listed and ranked as if they were parent companies.

<sup>d</sup> To allow comparison with arms sales in 2017, figures for arms sales in 2016 are given in constant 2017 US dollars.

<sup>e</sup> Trans-European refers to companies whose ownership and control structures are located in more than one European country.

<sup>f</sup> The arms sales figure for this company is an estimate with a high degree of uncertainty.

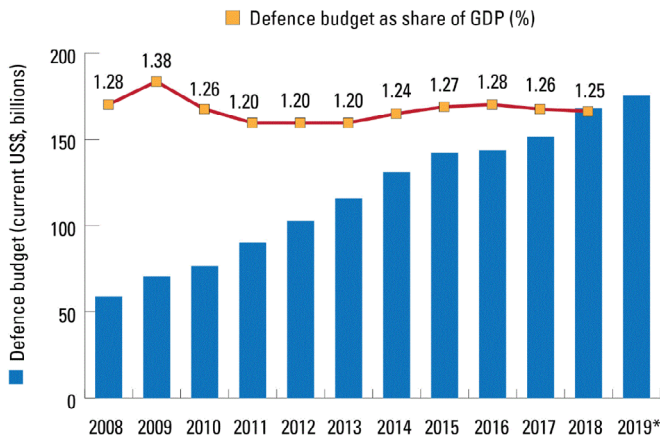
<sup>g</sup> Russian Electronics was formed following the merger of United Instrument Manufacturing Corporation and Russian Electronics. Its 2016 arms sales figures are 'pro forma', i.e. they are the combined 2016 arms sales of both companies.

<sup>h</sup> Hensoldt was created in 2017 as a result of the acquisition by an investment fund (KKR) of a German division of Airbus Group that produces military electronics. Its 2016 arms sales figures are 'pro forma', i.e. they are the arms sales of the division of Airbus Group in 2016.

<sup>i</sup> DXC is the result of the merger of Computer Sciences Corporation with relevant parts of Hewlett Packard Enterprise Services' (HPES) business. Its 2016 arms sales figures are 'pro forma', i.e. they are the arms sales of the estimated arms sales of the parts of HPES included in DXC.

Source: SIPRI Arms Industry Database, Dec. 2018.

### China's defence budget, 2008–19



\*PRC announced defence budget 2019

**Table 1.** The 25 largest exporters of major arms and their main clients, 2014–18

Note: Percentages below 10 are rounded to 1 decimal place; percentages over 10 are rounded to whole numbers.

Exporter	Share of arms exports (%)		Per cent change from 2009–13 to 2014–18 <sup>a</sup>	Main clients (share of exporter's total exports, %), 2014–18		
	2014–18	2009–13		1st	2nd	3rd
1 United States	36	30	29	Saudi Arabia (22)	Australia (7.7)	UAE (6.7)
2 Russia	21	27	-17	India (27)	China (14)	Algeria (14)
3 France	6.8	5.1	43	Egypt (28)	India (9.8)	Saudi Arabia (7.4)
4 Germany	6.4	6.1	13	South Korea (19)	Greece (10)	Israel (8.3)
5 China	5.2	5.5	2.7	Pakistan (37)	Bangladesh (16)	Algeria (11)
6 United Kingdom	4.2	4.3	5.9	Saudi Arabia (44)	Oman (15)	Indonesia (11)
7 Spain	3.2	2.9	20	Australia (42)	Turkey (13)	Saudi Arabia (8.3)
8 Israel	3.1	2.1	60	India (46)	Azerbaijan (17)	Viet Nam (8.5)
9 Italy	2.3	2.7	-6.7	Turkey (15)	Algeria (9.1)	Israel (7.6)
10 Netherlands	2.1	1.9	16	Jordan (15)	Indonesia (15)	USA (11)
11 South Korea	1.8	1.0	94	Indonesia (17)	Iraq (17)	UK (15)
12 Ukraine	1.3	2.7	-47	China (27)	Russia (23)	Thailand (14)
13 Switzerland	1.0	0.9	20	Saudi Arabia (19)	China (18)	Indonesia (9.3)
14 Turkey	1.0	0.4	170	UAE (30)	Turkmenistan (23)	Saudi Arabia (10)
15 Sweden	0.7	1.9	-62	Saudi Arabia (16)	UAE (14)	Algeria (10)
16 Canada	0.6	0.9	-33	Saudi Arabia (22)	India (13)	UAE (7.6)
17 Norway	0.5	0.6	-12	Oman (28)	Finland (23)	USA (21)
18 UAE	0.3	0.2	103	Egypt (41)	Jordan (10)	Yemen (7.6)
19 Czechia	0.3	0.1	472	Iraq (40)	USA (17)	Viet Nam (9.9)
20 Belarus	0.3	0.5	-26	Viet Nam (37)	Sudan (18)	Myanmar (12)
21 Australia	0.3	0.3	3.9	USA (53)	Indonesia (25)	Oman (8.8)
22 South Africa	0.3	0.5	-35	USA (21)	UAE (21)	India (9.8)
23 Brazil	0.2	0.2	21	Afghanistan (32)	Indonesia (25)	Lebanon (9.1)
24 Finland	0.2	0.2	-9.1	Poland (56)	UK (7.1)	Sweden (6.7)
25 Portugal <sup>b</sup>	0.2	0.0	457	Romania (89)	Belgium (7.0)	Uruguay (2.7)

UAE = United Arab Emirates.

<sup>a</sup> Figures show the change in volume of the total arms exports per exporter between the 2 periods.

<sup>b</sup> For Portugal, the percentage change from 2009–13 to 2014–18 is 0.03%.

Source: SIPRI Arms Transfers Database, Mar. 2019.

The French president Macron and the German Chancellor Merkel have in fact announced for the first time that the preparation of the common project for the new Future Combat Air System (FCAS) started as early as on July 2017, with the aim of creating both a fighter jet and a vast array of weapons and associated defence systems, including future generation drones. Spain has also announced its participation in the implementation and industrial partnership for these European programs. The two aeronautical companies should present the prototypes of the aircraft and turbines that will equip it by mid-2019 and the new Eurofighter will be implemented and assigned to the partner countries Air Force starting the 2025.

A target that will expand competitiveness by European players in the aerospace sector such as Airbus, Dassault, Leonardo, Thales; ThyssenKrupp; Krauss-Maffei Wegmann, Safran, Navantia, Aemnova Aerospace, Saab AB (mentioning the most competitive players in defence and aerospace groups) but also in the energy, robotics, environment and above all cyber war, which perceive competitiveness in more explicit terms the increasingly close interference of antagonistic countries, with the threat to internal security, both military and political.

Some data may better focus Europe position in the Defence industry better appreciated than commonplaces circulating in the international arena would try to endorse. “Creating a fully-fledged European Defence Union by 2025”<sup>36</sup> is imperative to Europe’s security and to build a Union that protects, as I mentioned before. A smooth, efficient and effective movement of military personnel and assets across and beyond the EU will enhance preparedness and response to crises. It will enable EU Member States to act faster, in line with their defence needs and responsibilities, both in the context of the Common Security and Defence Policy missions and operations, and in the framework of national and multinational activities.

Currently, cross-border mobility is still hampered by a number of barriers that can lead to delays, disruption, higher costs or increased vulnerability”, Jean-Claude Juncker President of the European Commission stated firmly on the State of The Union report on 2017. European Union has now its new President of the Commission just elected by the Parliament, Ursula von der Leyen<sup>37</sup>, a quite determined personality, former Defence Minister of Germany, the first woman leading the governance of EU since the its constitution on 1956 in Rome. EU will have a new Commission and the elected President. We will follow the developments on these issues.

In fact, Dassault Aviation and Airbus (now the world’s leading civil aircrafts manufacturer), have announced that they will implement, by 2024, a new advanced air superiority stealth aircraft - a jet that will replace the French Dassault Rafale and the Airbus Eurofighter series - with a political decision that will dilute de facto EU countries availability to ordering high numbers in the acquisition of the US produced F-35 last stealth version, as recently Japan had announced to have already chosen for its future air force.

France, Germany, Spain and other European countries are aspiring to be competitive with a new edition of the Eurofighter stealth as well and the collateral full equipment<sup>38</sup>, dedicating a relevant financial endowment of Euro to these medium term technologic defence/civil achievements.

Of course, the specificities of the defence and military industrial productions facing with the civil ones have peculiars but not as much as in the far past, when the technologic knowledges divide for the two sectors was a sharp border line, with a limited integration and sharing. The case of Airbus is an example of industrial

<sup>36</sup> [https://www.iss.europa.eu/sites/default/files/EUISSFiles/EXPO\\_STU%282019%29603478\\_EN1.pdf](https://www.iss.europa.eu/sites/default/files/EUISSFiles/EXPO_STU%282019%29603478_EN1.pdf)

<sup>37</sup> [https://ec.europa.eu/commission/biography-candidate-present\\_en#biography-of-the-candidate-for-president](https://ec.europa.eu/commission/biography-candidate-present_en#biography-of-the-candidate-for-president)

<sup>38</sup> Creating a fully-fledged European Defence Union by 2025; <https://euro-sd.com/2019/06/articles/13666/a-long-life-for-the-spanish-eurofighter/>

successful strategies where France, Germany but also UK (stepping out just few years ago), and now with Italy, Spain and other EU partners are sharing advanced projects the group based in Toulouse.

But after the Airbus let mention one of the others new top ten main player: the Italian Leonardo Group Aerospace, Defence and Security, a really value chain protagonist in these wide dual-technologies industrial sectors: Leonardo Group<sup>39</sup>.

Three years ago, Leonardo Group merged and aggregated all the top national industries with consolidated dual-tech knowledges and capabilities, outstanding human capital and constant attention to innovation was launched in 2017, in order to compete and grow in market shares and industrial international partnerships. These factors have led the Italian Group to become one of the top ten players in the world Aerospace, Defence and Security, with revenues of € 12.2 billion last year, 85% of which deriving from international markets. This Industrial Group global company is a partner of choice for many governments, institutions and Armed Forces, as well as for private customers and entities.

The fan of systems and products offered is wide: products and integrated solutions based on cutting-edge technologies with dual-use applications, to strengthen global security; protect people, the territories, infrastructures and information networks; contribute to the sustainable management of the environment, urban spaces and climate. Leonardo Group ensures that customers to obtaining the most value from offered systems through innovative support and training services. Many of the global most advanced defence fighters, helicopters, electronic advancements, air space control and advanced warfare equipment come from European consortium and industrial groups as the one now mentioned. The convergence into value chains<sup>40</sup> (by the way, the main focus of our Conference here in Singapore) of the most important industrial groups supplying products and equipment both for wide civil output and specific industrial chain and for the defence sectors, moreover, is very supportive in the highest international relations because involving all the main EU countries.

Their most active industrial groups in the defence sector by the way had resulted in many successful outcomes and some few failures. Of course, it was emerging - in the years coming close to the present dual high-tech extraordinary jump ahead, both in civil and military products - some recent frictional approaches between US and EU<sup>41</sup> on military industry and defence dual technologies.

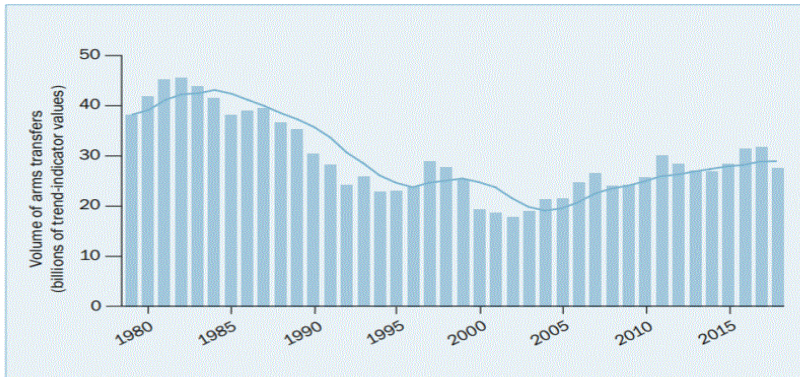
To talk of a new industrial revolution might sound pleonastic but in fact we really are moving in an industrial and connected services territory never before experienced, with efficient value chains already well established, specifically for European industries, from main groups to SME's companies.

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<sup>39</sup> <https://www.leonardocompany.com/home>

<sup>40</sup> <https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/industry-global-value-chains-connectivity-and-regional-smart-specialisation-europe-overview>

<sup>41</sup> <https://www.iss.europa.eu/sites/default/files/EUISSFiles/7%20US-EU%20defence%20industries.pdf>



**Figure 1.** The trend in international transfers of major arms, 1979–2018



(<https://ec.europa.eu>)

Internal Market, Industry, Entrepreneurship and SMEs

## European Defence Fund on track with €525 million for Eurodrone and other joint research and industrial projects

Published on: 19/03/2019

**The Commission has today adopted work programmes to co-finance joint defence industrial projects in 2019-2020 worth up to €500 million. A further €25 million have been earmarked to support collaborative defence research projects in 2019, with calls for proposals launched today.**

The **Juncker** Commission is making an unprecedented effort to protect and defend Europeans. From 2021, a fully-fledged European Defence Fund will foster an innovative and competitive defence industrial base and contribute to the EU's strategic autonomy. Through two precursors to the Fund, the Commission is taking steps to make defence cooperation under the EU budget a reality as of now. The Preparatory Action on Defence Research (PADR) continues to deliver for the third year running. And with today's decisions, the Commission kick-starts the first EU-funded joint defence industrial projects through the European Defence Industrial Development Programme (EDIDP). This will focus on areas including drone technology, satellite communication, early warning systems, artificial intelligence, cyberdefence or maritime surveillance.

Vice-President Jyrki **Katainen**, responsible for Jobs, Growth, Investment and Competitiveness said: "Cooperation in defence is the only way to protect and defend Europeans in an increasingly instable world. We are doing our part. Joint projects are materialising. European Defence is happening. On the basis of this successful experience we will scale up funding to have a fully-fledged European Defence Fund in place in 2021."

Commissioner Elżbieta **Bieńkowska**, responsible for Internal Market, Industry, Entrepreneurship and SMEs, added: "To ensure Europe can protect its citizens, we need cutting-edge defence technology and equipment in areas like artificial intelligence, drone technology, satellite communication and intelligence systems. With the EU investments we are



launching today, we are going from ideas to concrete projects, we are strengthening the competitiveness of our defence industries."

#### Joint development of defence equipment and technology:

The first European Defence Industrial Development Programme (EDIDP) work programme agreed with the EU countries provides €500 million in co-financing for the joint development of defence capabilities during 2019-2020. In the coming days the Commission will publish 9 calls for proposals for 2019, and 12 further calls will follow for 2020. These calls will cover priority areas in all domains – air, land, sea, cyber and space:

- **Enabling operations, protection and mobility of military forces:** €80 million is available to help develop CBRN threat detections capabilities or counter drone systems
- **Intelligence, secured communication & Cyber:** €182 million will cover cyber situational awareness and defence, space situational awareness and early warning capabilities, or maritime surveillance capabilities
- **Ability to conduct high-end operations:** €71 million will support the upgrade or the development of the next generation of ground-based precision strike capabilities, ground combat capabilities, air combat capabilities and future naval systems
- **Innovative defence technologies & SMEs:** €27 million will support solutions in Artificial Intelligence, Virtual Reality and Cyber technologies, as well as to support SMEs
- **In addition, two projects have been proposed for direct award:** €100 million to support the development of the **Eurodrone**, a crucial capability for Europe's strategic autonomy, and €37 million to support **ESSOR** interoperable and secure military communications

#### Financing innovation in defence research:

Today Commission publishes calls for proposals under the Preparatory Action on Defence Research (PADR), the third and final budget tranche under the Juncker Commission. The 2019 Work Programme will dedicate €25 million for research in Electromagnetic Spectrum Dominance and Future Disruptive Defence Technologies - two areas identified as essential to maintain Europe's technological lead and independence in the long-term.

The calls on Future Disruptive Defence Technologies will look at how best the EU can support disruptive technologies in defence that may lead to transformational changes in the military. This will help prepare the ground for the European Defence Fund which could allocate up to 8% of its budget for disruptive technologies.

## Next steps

Eligible consortia can apply to the 2019 calls for proposals until the end of August. The first projects will be selected before the end of 2019, followed by the official signing of grant agreements.

With both programmes now operational and running, the Commission is paving the way for a fully-fledged European Defence Fund for the next financial period 2021-2027.

## Background

In his political guidelines in June 2014, President Juncker made strengthening European citizens' security a priority. He announced the creation of a European Defence Fund in his 2016 State of the Union address. The Commission presented a first set of actions in June 2017 to allow defence cooperation at EU level to be tested by means of the Preparatory Actions on Defence Research for 2017-2019, as well as through the European Defence Industrial Development Programme for 2019-2020.

In June 2018, the Commission proposed a fully-fledged €13 billion European Defence Fund. The Fund will place the EU among the top 4 defence research and technology investors in Europe, and act as a catalyst for an innovative and competitive industrial and scientific base. The EU institutions in February 2019 reached a [partial political agreement on](#)

With a yearly turnover of EUR almost 100 billion, 500.000 directly employed and 1.2 million indirect jobs, the European defence industry is a vital, competitive industrial sector. It is characterized by economic and technological components that are valuable factors for EU industrial competitiveness and partnership in the world.

France and Germany announced this year a start-up of 65 million euro contracts, equally funded by both countries, to launch the joint program to build the before mentioned sophisticated and highly advanced fighter interdiction multitasking role jet new-generation, for long-range missions capabilities.

For the same crucial reasons, the future of the advanced technologies and the values added transferred through the defence and security procurements of the European Union to the partner countries even beyond the EU members - as de facto in the past had been successfully developed, to other no-members countries relevant from the point of view of technologic high competences, research involvement and strategic choices - the European industrial civil sectors structure competitiveness and high technologic achievements capabilities have a vital integrated value added in the really critical value added widening of dual technologic sharing standards with other partner countries. And of course "Europe First" is so far from the cultural and intellectual vision of mainly all the Europeans citizens to emerging as an effective deterrence for any supremacist velleitarian slogan disturbing their political vision and scopes.

In the past, the same had happened in the car factories industries sectors, until when the European main groups had competitive and ready to start the acquisition of factories and groups in Asia and in the Americas, starting from U.S. and moving further in other deals, investments, merger and acquisitions.

Of course, the specificities of the defence and military industrial productions facing with the civil ones have peculiars but not as much as in the far past, when the technologic knowledges divide for the two sectors was a sharp border line, with a limited integration and sharing.

The case of Airbus<sup>42</sup> is a global example of industrial successful strategies where France, Germany and UK (unfortunately stepping out just few years ago), are sharing also with Italy and Spain joint civil-military projects with the Group based in Toulouse. And even now, many of the European most advanced defence fighters, helicopters, electronic advancements, and air space control, advanced warfare equipment come from EU consortium and industrial groups, even so with U.S. top defence industries exporter to European countries very relevant productions and technologies. As said, no monopolistic strategies are still available in the third millennium.

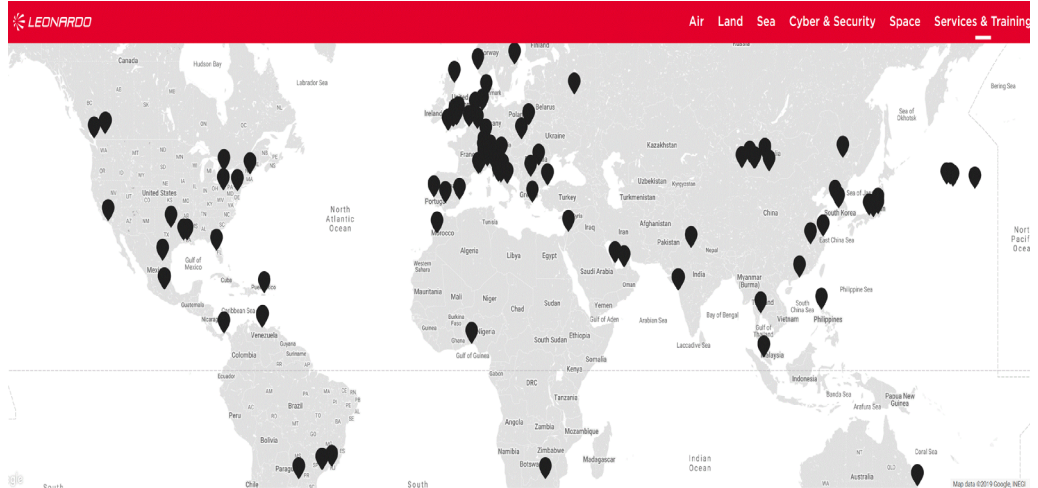
But as Italian, let me introduce also a not very known but really top standing in these industrial sectors, Leonardo Group<sup>43</sup>, where three years ago converged top national industries with consolidated tech knowledges and capabilities, together with outstanding human capital and constant attention to innovation, launched in 2017 to compete and grow in market shares and industrial international partnerships . "These factors have led the Italian Group to become one of the top ten players in the world

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<sup>42</sup> <https://www.airbus.com/>

<sup>43</sup> <https://www.leonardocompany.com/home>

Aerospace, Defence and Security, with revenues of € 12.2 billion, 85% of which deriving from international markets. A sustainable business approach and a disciplined financial strategy are the main pillars on which we base the creation of value for all of our stakeholders.



The Company is a partner of choice for governments, institutions and Armed Forces, as well as for private customers and entities. The fan of systems and products offered is wide: products and integrated solutions based on cutting-edge technologies with dual-use applications, to strengthen global security; protect people, the territories, infrastructures and information networks; contribute to the sustainable management of the environment, urban spaces and climate. Leonardo ensures that customers to obtaining the most value from offered systems through innovative support and training services. “Air, land, sea, space and cyberspace: wherever defence and security are needed Leonardo have effective solutions for requirements through a complete and integrated offer in strategic sectors such as helicopters, aeronautics, unmanned systems, defence and security electronics, defence systems and satellite systems and services”. The convergence into value chains<sup>44</sup> (by the way, the main focus of our Conference here in Stockholm) of the most important industrial groups supplying products and equipment both for wide civil output and specific industrial chain and for the defence sectors, moreover, is very supportive in the highest international relations because involving all the main EU countries.

Their most active industrial groups in the defence sector by the way had resulted in many successful outcomes and some few failures. Of course, it was emerging - in the years coming close to the present dual high-tech extraordinary jump ahead, both in civil and military products - some recent frictional approaches between US and EU<sup>45</sup> on military industry and defence dual technologies.

<sup>44</sup> <https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/industry-global-value-chains-connectivity-and-regional-smart-specialisation-europe-overview>

<sup>45</sup> <https://www.iss.europa.eu/sites/default/files/EUISSFiles/7%20US-EU%20defence%20industries.pdf>

To talk of a new industrial revolution might sound pleonastic but in fact we really move in a new industrial and connected services territory never before discovered.

The convergence of the most important industrial groups in the supply of products and equipment both for wide civil output and specific industrial chain and line for the defence sectors, moreover, is very supportive in the highest international relations because involving all the main EU countries. Their most active industrial groups in the defence sector by the way had resulted in many successful outcomes and some few failures. Of course, it was emerging - in the years coming close to the present high-tech extraordinary jump ahead, both in civil and military products - some recent frictional approaches between US and EU<sup>46</sup> on military industry and defence dual technologies. EU had been accustomed since in the past. Joint ventures to the defence industries sharp competition sharing production parts and crucial sophisticated technologies, both in the frame of NATO<sup>47</sup> allies, U.S. and Canada in highest roles but as well with other global advanced industrial partners worldwide<sup>48</sup>.

For sure Europe in this moment and looking to future had reached a very advanced dual technologies defence industrial player competitiveness goal. As well supply chain successful examples I had chosen to bring to your attention, to avoid our Singapore Economic Review 2019 would miss these relevant dimensions of the international industrial value chains. EU and Asia security cooperation is in fact indispensable to pilot in safe way the international relations worldwide.

This paper had been closed on August 20, 2019

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<sup>46</sup> <https://www.iss.europa.eu/sites/default/files/EUISSFiles/7%20US-EU%20defence%20industries.pdf>

<sup>47</sup> [https://www.nato.int/nato\\_static\\_fl2014/assets/pdf/pdf\\_2019\\_06/20190625\\_PR2019-069-EN.pdf](https://www.nato.int/nato_static_fl2014/assets/pdf/pdf_2019_06/20190625_PR2019-069-EN.pdf)

<sup>48</sup> ISS\_Eva\_Pejsova\_EU and Asia security cooperation, Paris 2019 - [https://www.iss.europa.eu/search-view?search\\_text=Eva+Pejsova+EU+and+Asia+security+cooperation](https://www.iss.europa.eu/search-view?search_text=Eva+Pejsova+EU+and+Asia+security+cooperation)

**ANNEX <sup>49</sup>** slides from Report Accenture: Harness the Engine of Innovation, Report 2019

# FIVE TECHNOLOGY TRENDS RESHAPING AEROSPACE AND DEFENSE

This year's Accenture Technology Vision for the aerospace and defense industry highlights five emerging trends that will have a decisive impact on the entire value chain, from aircraft design to passenger or pilot experience. In each trend, digital saturation is raising expectations, abilities and risk across industries, as well as shaping how businesses are seeking new ways to differentiate themselves as the world moves toward the post-digital era.

TREND

1

## DARQ Power

### Understanding the DNA of DARQ

The next set of technologies every company will need to master? Distributed ledger technology (DLT), artificial intelligence (AI), extended reality (XR) and quantum computing. In other words, "DARQ" matters.

Individually, each of these four technologies represents opportunities for aerospace and defense companies to differentiate their products and services. Collectively, they will open unimagined new pathways into the future. AI already plays a critical role in optimizing processes and influencing strategic decision-making. XR, an immersive technology, creates entirely new ways for people to experience and engage with the world around them. Distributed ledgers will expand networks by eliminating the need for trusted third parties. And quantum technology will usher in novel ways to approach and solve the hardest computational problems.

**84% of aerospace and defense companies are already experimenting with one or more DARQ technologies, expecting them to be key differentiators.** Each technology is at a different point on the adoption curve, but the first wave of companies using DARQ technologies to drive differentiation is already here.

<sup>49</sup> Accenture, Harness the Engine of Innovation, Report 2019

<https://www.accenture.com/us-en/insights/high-tech/tech-vision-aerospace-defense>

TREND

2

## Get to Know Me

### Unlock unique customers and unique opportunities

Technology identities are part of an emerging enterprise feedback loop, one that first began to show its potential with the personalization efforts of the digital era. Through digital technologies, aerospace and defense companies gain new, direct touchpoints with customers.

They use the resulting “snapshots” of insight into customer needs and goals to deliver personalized products and services, which, in turn, give them even more insight into their customers.

Now, that technology-driven feedback loop is about to kick into overdrive. As the world moves into the post-digital era, aerospace and defense companies are beginning to build new products and services that shift to individualized experiences, creating a one-to-one relationship with each customer where technology plays the starring and ever-present role.

**76% of aerospace and defense business leaders agree that understanding customers’ behaviors around technology will be critical for their organizations to increase customer loyalty.** To this end, savvy aerospace and defense businesses are taking their first steps with technology identities to personalize their existing product and service offerings. Leaders can push even further to craft new individualized, experiential business models entirely around the technology identities of their customers.

TREND

3

## Human+ Worker

### Change the workplace or hinder the workforce

Aerospace and defense companies have not been going through their digital transformations alone. Today’s workers are equipped and empowered by technology, incorporating it to perform existing roles in new ways and to adapt for new roles that did not exist in the pre-digital era. The workforce is becoming “human+”: each individual is empowered by their skillsets and knowledge plus a new, constantly growing set of capabilities made possible through technology.

But as the line between employees and the technology they use blurs, a new divide is emerging. The workforce is evolving at a rapid pace, incorporating new technology-driven abilities and skills to deliver value for the company—while the enterprise itself is still optimized for the workforce of the past. **69% of aerospace and defense executives believe that their employees are more digitally mature than their organization, resulting in a workforce ‘waiting’ for the organization to catch up.**

TREND

4

### Secure US to Secure ME Enterprises are not victims, they're vectors

Today's ecosystem-dependent business world amplifies the impact of cyberattacks. Incidents that cripple one enterprise can grow rapidly and expand to threaten a company's ecosystem, industry and beyond. As aerospace and defense companies work more and more extensively within complex ecosystems, they are simultaneously extending, and absorbing, their ecosystem partners' risks and vulnerabilities. Those risks include the loss of current and future defense contracts as a result of not protecting client information or failing to comply with national cybersecurity regulations.

Threat actors targeting highly sensitive and proprietary data see aerospace and defense ecosystems as an ever-widening attack surface. But most companies still view cybersecurity as strictly an individual effort. Only 40% of aerospace and defense business and IT executives report that they know their ecosystem partners are working diligently, like they are, to be compliant and build security resilience.

To respond to this dichotomy, organizations must include growing ecosystem dependencies and risks as part of their own security posture and make security a cardinal component of how they build, assess, monitor and manage partnerships. Interconnectedness increases companies' exposures to risks. Leading aerospace and defense companies are recognizing that while they already collaborate to deliver best-in-class products, services and experiences, it is high time security joins that effort as well.

TREND

5

## MyMarkets

### Meet customer's needs at the speed of now

With companies, workforces, consumers and industries now inextricably connected, being digital is no longer enough for an aerospace and defense firm to differentiate itself. But it does give organizations a foothold for their next big opportunity: capturing moments.

With direct digital access to customers and increasingly powerful analytics capabilities, aerospace and defense companies can understand their current and potential markets better than ever before. And with sophisticated backend technology that can reorient the business quickly, they can deliver for those momentary markets faster than ever before. Put those capabilities together and every moment is a chance to deliver a new product or service designed not just for a specific customer, but for their needs at a specific point in time.

81% of aerospace and defense companies agree the integration of customization and real time delivery is the next big wave of competitive advantage.

**The workforce is evolving at a rapid pace, incorporating new technology-driven abilities and skills to deliver value for the company—while the enterprise itself is still optimized for the workforce of the past.**



# THE ANSWER? A NEW KIND OF LIVING BUSINESS

Aerospace and defense companies have been developing digital capabilities for years. Yet the urgency to harness digital to deliver the “moments that matter” across the organization, partners and customers has never been greater.

## PATHWAYS TO A LIVING BUSINESS

