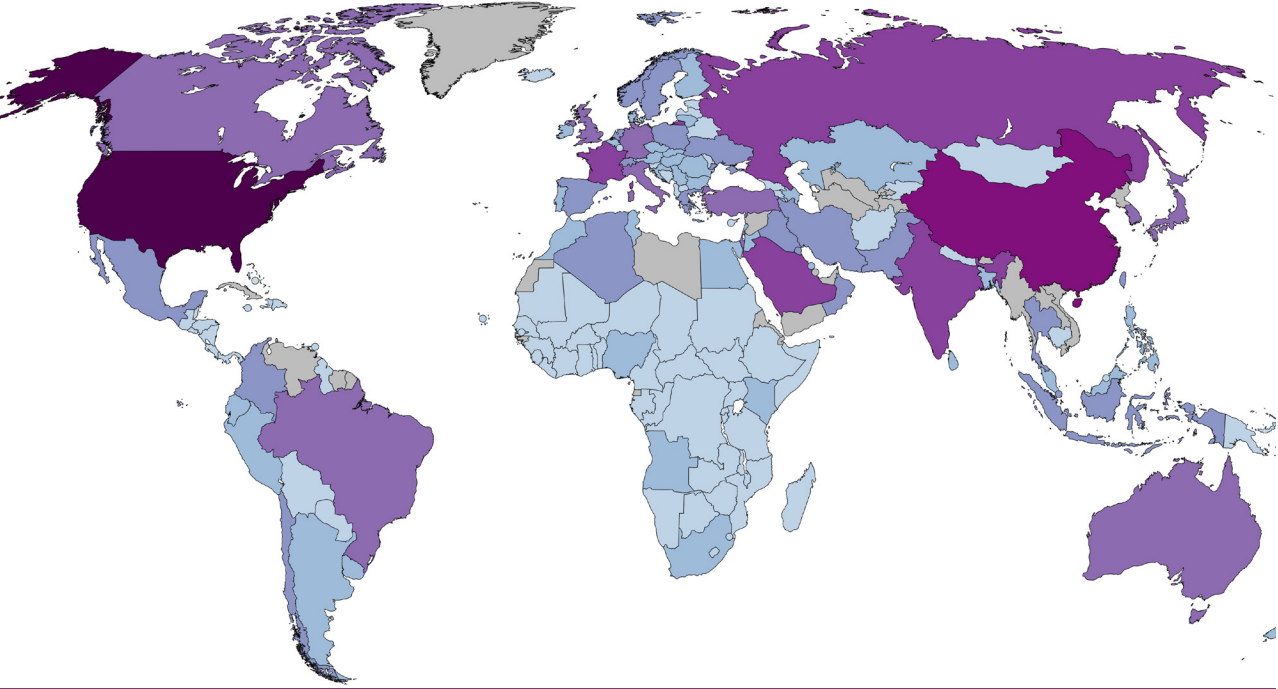

Defence Economic Outlook 2020

An Assessment of the Global Power Balance 2010-2030

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Summary

The global military and economic power balance has changed significantly during the past decade. While the US and its European allies still possess a clear military advantage, major non-Western powers such as China and Russia have steadily narrowed this gap. The past decade, China's share of global military spending as well as its share of the world economy has increased considerably. In recent years, the US and several European countries have refocused their attention towards great power rivalry and increased their military spending. This may slow, but is unlikely to reverse, the observed trends of the past decade.

It is the assessment of this study that the US will continue to enjoy an overall military advantage in 2030. However, the Chinese economy is likely to become the world's largest, and the Chinese navy will likely outnumber its US counterpart, around the same time. Continued growth of European military expenditure is far from certain, however, the Eurozone's economic advantage over Russia seems set to increase. Nevertheless, Russia is likely to retain and even strengthen its military capabilities. These assessments are not predetermined, nor are they indisputable. They are, however, based on detailed data as well as clearly defined and motivated assumptions.

Keywords: Power balance, military expenditure, economy, equipment

Sammanfattning

Den globala militära och ekonomiska maktbalansen har förändrats avsevärt under det senaste årtiondet. Medan USA och dess europeiska allierade fortsatt innehar ett tydligt militärt övertag, har icke-västliga stormakter såsom Kina och Ryssland stadigt minskat detta gap. Det senaste årtiondet har Kinas andel av världens militära utgifter såväl som dess andel av världsekonomin ökat betydligt. På senare år har USA och flertalet europeiska länder lagt större fokus på stormaktsrivalitet och ökat sina militära utgifter. Detta kan sakta ner, men kommer osannolikt vända, de senaste årtiondets observerade trender.

Det är denna studies bedömning att USA kommer fortsätta inneha ett övergripande militärt övertag år 2030. Däremot kommer den kinesiska ekonomin sannolikt bli världens största och den kinesiska flottan sannolikt uppnå en större numerär än den amerikanska, runt samma tid. Fortsatt tillväxt av Europas militära utgifter är långt ifrån garanterad. Däremot förefaller Eurozonens ekonomiska övertag gentemot Ryssland öka. Trots detta är det sannolikt att Ryssland kommer att bibehålla, till och med stärka, sina militära förmågor. Dessa bedömningar är inte förutbestämda, inte heller är de obestridliga. De är däremot baserade på detaljerad data såväl som tydligt definierade och motiverade antaganden.

Nyckelord: Maktbalans, militära utgifter, ekonomi, materiel

Contents

1 Introduction

The aim of Defence Economic Outlook 2020 is to assess the global power balance in terms of military expenditure, macroeconomic trends, and quantities as well as quality of military equipment among major world powers between 2010 and 2019. The report also aims to provide a broad assessment of future trends with regard to the same aspects from 2020 to 2030.

This report is the third in the biennial series Defence Economic Outlook (DEO),[1] published by the Swedish Defence Research Agency (FOI). The long-term goal of the DEO report series is to gain an increasingly nuanced and accurate picture of the global power balance. This is done by gradually including additional aspects to the assessment of military and economic power.

While DEO 2016 focused on input measures, such as military expenditure and gross domestic product, DEO 2018 added the aspect of military equipment quantities. The 2020 edition takes one additional step by assessing indicators of military equipment quality. Although far from providing a complete analysis of the global power balance, taken together, the included aspects should provide a fairly nuanced and hopefully accurate assessment of the broader international defence economic trends.

The DEO report series is also part of a larger, ongoing, project which aims to develop the methods used in the series and to complement existing well-established databases, by collecting open source data. The project also involves developing tools for assessing military equipment performance. Furthermore, it includes studies related to defence specific purchasing power, as well as country specific and regional studies. Although much progress has been made for this edition of DEO, methods and data will continue to be refined.

[1] Previous reports include Olsson, Per; Alozious, Juuko & Ädel, Maria (2018) *Defence Economic Outlook 2018 – Global Outlook with a Focus on the European Defence Industry*, and Olsson, Per & Bäckström, Peter (2016) *Defence Economic Outlook 2016 – Global Outlook with a Focus on the Baltic Sea*.

2 Methods and Delimitations

The global power balance in this report is assessed from two perspectives, military power and economic power. In the context of international relations, military power can be used by countries as a means of achieving political goals through conflict, coercion or deterrence. In this study military power is assessed in terms of military expenditure, military equipment quantity and military equipment quality. Economic power provides countries with influence in terms of consumption, production, investment, finance and trade. In this study, however, economic power is limited to being assessed in terms of gross domestic product (GDP).

2.1 Method and Data

This report focuses on the major world powers of the US, China, the four largest military spenders in Europe (consisting of France, Germany, the UK, and Italy, in this study referred to as the E4), and Russia.

Data on military expenditure, GDP and military equipment quantities, are collected from well-established and often used data sources. Data on indicators of equipment quality and complementary data on naval tonnage, have been collected from a wide range of open sources. Estimates of future navy equipment quantities are also based on data obtained from various open sources and collected in internal databases at FOI. Data which have been collected by FOI from several open sources are referred to collectively by the designation "FOI" in this report.

Military Expenditure

Military expenditure measures the resources allocated to defence and defence related items. It is, in other words, an input measure and should not be equated with the output of military capability. However, expenditure is a key prerequisite for capability building and as such provides insights into the global power balance. In this report, military expenditure data are collected from Stockholm International Peace Research Institute (SIPRI).[2] It is worth noting that SIPRI's definition of military expenditure not only includes direct expenditure on armed forces, but all spending related to military activities such as paramilitary forces, military space activities, military pensions, as well as research and development.[3]

Military expenditure is usually expressed in terms of market exchange rates (MER) USD, including SIPRI's data. This measure, however, tends to fluctuate on a yearly basis depending on the relative value of the local currency versus the USD.

[2] SIPRI (2020a) *SIPRI Military Expenditure Database*.
[3] For a more detailed description of SIPRI's definition, see SIPRI (2020) *SIPRI Military Expenditure Database: Sources and Methods*. (Accessed 29 October 2020).

Furthermore, MER does not account for differences in purchasing power. Generally, the amount of goods and services which can be bought by a certain amount of USD varies between countries. Most often, a given amount of USD can buy larger volumes in lower-income countries compared to high-income countries. Purchasing power parity (PPP) aims to address this issue by comparing prices on constructed "baskets" of comparable goods and services, thereby adjusting for differences in costs between countries. This could be especially valid when comparing high- and low-income countries which have large domestic defence industries. Data on PPPs are collected from the Organisation for Economic Co-operation and Development (OECD).[4] However, using PPP estimates in the context of military spending is by no means unproblematic. Military spending includes several costs, both in terms of manpower and equipment, which are specific to defence and unlikely to be reflected in the general PPP measures adapted to compare GDP. Therefore, PPP is unlikely to be directly transferable to military expenditure without first adjusting for these likely differences.[5] This study does not imply that PPP is a preferable method of estimating military expenditure. However, PPP does address some of the issues with MER and consequently provides an alternative approach to quantify military spending, which at the very least merits a discussion.

Macroeconomic Trends

Economic power, in this study is illustrated through macroeconomic trends and expressed in terms of GDP, is in itself an important factor when assessing the global power balance. In the context of defence economics, GDP can also be seen as an important prerequisite for military expenditure.[6] GDP data between 2000 and 2019 have been collected from the World Bank.[7] In this report, GDP is expressed in both MER and PPP. Even in the context of GDP, for which the PPP estimates are adapted, PPP is still not unproblematic. The exact content of the "baskets" of

[4] OECD (2020a) *Purchasing power parities (PPP)*. (Accessed 29 October 2020).

[5] For a detailed discussion concerning the benefits and problems with using purchasing power parities for estimating military expenditure, see e.g. SIPRI (2020) *Frequently Asked Questions* – 12. Accessed 23 November 2020 and Kofman, Michael & Connolly, Richard (2019) "Why Russian Military Expenditure Is Much Higher Than Commonly Understood (As Is China's)", *War on the Rocks*. For previous literature estimating defence specific PPPs, see e.g. Robertson, Peter E. and Sin, Adrian (2017) "Measuring hard power: China's economic growth and military capacity", *Defence and Peace Economics*, 28:1.

[6] Apart from the general observation that economic size and military spending tend to correlate over time and between countries, several studies point to a statistically significant positive correlation between developments in GDP and military expenditure even when other factors are accounted for, see e.g. Douch, Mohamed & Solomon, Binyam (2014) "Middle Powers and the Demand for Military Expenditure", *Defence and Peace Economics*, 25:6, Wang, Yu (2013) "Determinants of Southeast Asian military spending in the post-cold war era: a dynamic panel analysis", *Defence and Peace Economics*, 24:1, Nikolaidou, Eftychia (2008) "The demand for military expenditure: evidence from the EU15", *Defence and Peace Economics*, 19:4, Dunne, J. Paul; Nikolaidou, Eftychia & Mylonidis, Nikolaos (2003) "The demand for military spending in the peripheral economies of Europe", *Defence and Peace Economics*, 14:6. In similar "demand for defence" studies gross domestic product or gross domestic income are often used as control variables.

[7] World Bank (2020a) *GDP Constant 2010 US$*. (Accessed 29 October 2020).

goods and services, on which these estimates are based, may vary somewhat between countries, as may the relative value of the included goods and services. In other words, it can be difficult to find perfectly comparable "baskets", and PPPs therefore risk either to over- or undervalue a given country's purchasing power. Nevertheless, given the issues with MER that PPPs are meant to address, these estimates are included in the assessment of the global economic power balance.

Military Equipment Quantities

In addition to looking at military expenditure, military equipment quantity offers a complementary aspect when assessing and comparing military power. For the naval equipment of major world powers, the numbers of surface combatants and submarines are listed. These are presented according to vessel type, which may have different roles and vary significantly in size. Therefore, total tonnage is presented as an alternative measure to assess fleet sizes. For army equipment, the number of main battle tanks, infantry fighting vehicles and armoured personnel carriers as well as artillery pieces and multiple launch rocket systems are included. For air forces, the number of combat aircraft, transport aircraft and bombers are listed. This study includes equipment classified as being "in active service" by the International Institute for Strategic Studies (IISS), from which the data on military equipment quantities have been collected.[8] Note that the IISS definition "in active service" generally does not account for availability. This implies that the numbers of combat ready platforms are likely lower than the quantities presented in this report. With regards to naval tonnage, the IISS data have been complemented by open source data.[9] For further details on classification and assumptions used in this report regarding military equipment quantity, see Appendix C.

Military Equipment Quality

The analysis of military equipment quality in this report consists of an initial categorisation according to modernity, where the selected types of navy, army and air force equipment are classified as either modern, intermediate or legacy. The basis for this classification varies depending on type of equipment, but generally corresponds with the age or the generation of the selected system. However, as the quality of modern equipment may vary significantly between countries and types of equipment, the broad categorisation according to modernity is complemented by outlining a series of quality indicators for key equipment within each service branch; surface combatants, main battle tanks and combat aircraft. Focusing on

[8] IISS (2020) *The Military Balance 2020*, IISS (2015) *The Military Balance 2015*, IISS (2010) *The Military Balance 2010*, IISS (2005) *The Military Balance 2005*, and IISS (2000) *The Military Balance 2000*.

[9] US tonnage is obtained from the Naval Registry (nvr.navy.mil), Russian tonnage from Russianships (russianships.info), French, German, UK and Italian tonnage from their respective official government or navy homepages. Chinese tonnage is obtained from international institutes, such as Janes and IISS or credible news outlets such as Navaltechnology.com and Military-today.com.

this limited number of performance indicators, this report does not claim to present a complete assessment of the full complexity that is equipment quality.

Assessments of military equipment quality are based on data collected from a wide range of open sources.[10] Navy surface combatant performance is assessed by the indicators number of missiles, maximum range and top speed of surface-to-air missiles (SAMs) and anti-ship missiles (ASMs) respectively. The number of torpedoes and helicopters carried is also included to give a broad assessment of anti-submarine warfare (ASW) capabilities.[11] Army main battle tank performance is assessed through the indicators firepower, protection and mobility.[12] Air force combat aircraft performance is assessed through the number of hard points, i.e. stations for missiles, bombs or additional fuel tanks, carried.[13] For further details on methods, data and assumption regarding equipment quality, see Appendix D.[14]

Future Trends

Assessments of future trends are based on a number of methods and open source data, collected from a wide range of sources. As mentioned above, GDP data for 2000 to 2019 are obtained from the World Bank, while estimates for 2020 to 2025 are collected from the International Monetary Fund (IMF).[15] The use of two different sources was necessary in order to construct a complete time series denoted in constant GDP, i.e. adjusted for inflation. While the World Bank provides data for constant GDP up until 2019, it does not provide future estimates of inflation adjusted real growth rates. IMF, meanwhile, does provide future estimates of real GDP growth rates from 2020 to 2025, but not historical GDP data in constant prices. For GDP forecasts beyond 2025 additional open sources were needed. For the US, forecasts beyond 2025 are based on estimates from the US Congressional

[10] For surface combatants the number of missiles, torpedoes and helicopters are obtained from IISS (2020) *The Military Balance 2020*, complemented by missile ranges and speeds from institutes, such as CSIS, or online sources such as Seaforces.org, Navaltechnology.com, Navyrecognition.com, and Armyrecognition.com. Main battle tanks performance data are obtained from US Training and Doctrine Command (2014) *Worldwide Equipment Guide 2014*, Vol. 1, as well as *Steelbeast.com*. Aircraft generations, number of hardpoints, range and speed, are obtained from online sources, such as Military-today.com, Aircraft-technology.com, and manufacturer data.

[11] For a more detailed discussion regarding estimates of surface combatant performance, see e.g. Arena, Mark V.; Blickstein, Irv; Younossi, Obaid & Grammich, Clifford A. (2006) *A Macroscopic Examination of the Trends in U.S. Naval Ship Costs Over the Past Several Decades*.

[12] For a more detailed discussion regarding estimates of main battle tank performance, see e.g. Olsson, Per (2018) *Towards a Tool for Measuring Military Performance*.

[13] For a more detailed discussion regarding estimates of combat aircraft performance, see e.g. Horowitz, Stanley A.; Harmon, Bruce R. & Levine, Daniel B. (2016) "Inflation adjustments for defence acquisition", *Defence and Peace Economics*.

[14] Other methods when assessing military equipment quality includes evaluations by procurement agencies, scenario based evaluations or simulations by operation analysts, as well as rankings by expert assessments. For examples of studies utilising the latter method, see e.g. Middleton, Andrew; Bowns, Steven; Hartley, Keith & Reid, James (2006) "The Effect of Defence R&D on Military Equipment Quality", *Defence and Peace Economics*.

[15] IMF (2020a) *World Economic Outlook Database*. (Accessed 23 November 2020).

Budget Office (CBO).[16] Meanwhile, Chinese real GDP growth rates after 2026 are based on projections made by the World Bank in 2013.[17] For the Eurozone, Russia and India, GDP forecasts proved more difficult to obtain. Instead, the growth rates of the past decade, as given by IMF data for 2010-2019, have been prolonged with some adjustments to serve as rough estimates of future macroeconomic trends.[18]

Future military expenditure depends both on future GDP and the political priority given to military expenditure. No exact estimates of future military expenditure are presented in this report, but future military spending is discussed given the assumption that military expenditure as share of GDP would remain the same in 2030 as in 2019.

Estimates of future quantities of military equipment focus on the naval equipment of major world powers. This is not due to any maritime bias, but a consequence of data availability. Hulls of ships and submarines are usually constructed several years before being commissioned into active service and data of hulls in various stages of construction are often obtainable. Meanwhile, it is far more difficult to obtain data on the overall larger volumes of army and air force equipment, which are consequently more difficult to estimate. In this study, surface combatants and submarines launched by 2020 are assumed to be taken into active service by 2025. Ships and submarines laid down or officially planned, but not yet launched, are assumed to be commissioned by 2030.[19] For the US, its officially stated plan of a 355-ship navy has been included as a benchmark.[20] These estimates have also been complemented by reasonable assumptions about future naval quantities. Future quantities of army and air force equipment are discussed rather than estimated. A detailed description of data and assumptions on future trends are presented and motivated in Appendix E.

2.2 Delimitations

This report focuses on quantifying and comparing resources which form the basis for military and economic power.[21] It does not strive to answer which country would win an armed conflict or who will assume global leadership. Such assessments would have to be context specific and take a wide range of additional factors into account. The report's focus on military and economic power means that other important forms of power are excluded, such as political influence through soft

[16] Congressional Budget Office (2020) *An Update to the Economic Outlook: 2020 to 2030*.
[17] World Bank (2013) *China 2030: Building a Modern, Harmonious, and Creative Society*.
[18] IMF (2020) *IMF Data – Real GDP growth (Annual percent change)*. (Accessed 29 October 2020).
[19] Data on future naval equipment are obtained from wide range of open sources, such as Janes, TheDiplomat.com, Navaltechnology.com, Defensenews.com, and Navyrecognition.com.
[20] Congressional Research Service (2020) *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*.
[21] For a critical perspective on the limitations with measuring gross resources as inputs of power, see e.g. Beckley, Michael (2018) "Power of Nations: Measuring What Matters", *International Security*, 43:2, pp. 7-44.

power.[22] This factor could be particularly important when discussing any country's potential for political clout and leadership.

This study focuses on state actors. This risks missing the important role played by international organisations and non-state actors in the current international security environment. Furthermore, the focus on the major world powers as individual countries risks missing the power of alliances and groups, such as the combined military power of NATO or combined economic strength of ASEAN.

The European perspective within this report changes between the four largest military spenders in Europe (E4) and the Eurozone, the E4 when assessing military expenditure and equipment, and the latter when assessing macroeconomic trends. This may cause confusion as the E4, although all of which are NATO members, do not form a separate group or alliance. Preferably, the military perspective would have included all European NATO allies, but collecting the necessary data for each type of equipment for each individual country was not possible within the scope of this report.

The macroeconomic assessment in this report focuses on GDP and does not assess trade or investment patterns, nor does it assess productivity, nor investments in research or technological sophistication of a given country's industrial base. Assessing economic power by GDP alone provides a very narrow definition of economic power. The motivation for this choice is to focus on the factor most relevant for a defence economic analysis, and GDP is a prerequisite for military spending.

While military expenditure, equipment quantities and quality provide indications about a given country's relative strengths and weaknesses, these indicators remain input measures and should not be equated with the far more complex concept of military capability. Any comprehensive assessment of military capability should include in-depth analyses of factors such as military doctrine, training, communications, logistics, leadership as well as political goals and geostrategic conditions. However, these important aspects of assessing military power are beyond the scope of this report.

The assessments of military equipment in this study is limited to conventional weaponry, meaning that analyses of nuclear, space, cyber and intelligence capabilities are not included. This limits the conclusions made in this report as nuclear capabilities are important aspects of the global power balance. Cyber, space and intelligence capabilities may act as complements to conventional military capabilities during conflicts as well as providing non-military and asymmetric capabilities in peace time, potentially yielding high results with limited resources. However, these aspects are beyond the scope of this study.

[22] For a global ranking of soft power, see e.g. McClory, Jonathan (2018) *The Soft Power 30 – A Global Ranking of Soft Power 2018*. Portland.

Assessing military equipment quality is highly complex, as there are multitudes of factors that any simplified analysis, by its very design, will omit. In a real world situation, any piece of military equipment cannot be evaluated in isolation. Not only will its operational availability depend on the degree of maintenance and spare parts, its operational value will also depend on the skill of its crew, whether it is being operated as designed, the availability of logistical support and its interoperability with other types of equipment. The performance data presented in this report are presented free of operational context and neither can nor is intended to answer which country would win a war, a battle or a duel. Performance data do, however, provide a broad idea of relative strengths given a limited number of quality indicators.

As explained in the previous section, estimates of future military equipment quantities will focus on navies, due to the lack of available data regarding future army and air force equipment. Similarly, due to lack of data, future military equipment quality is only discussed in broad terms based on open source information. With regards to future equipment quality, the report does not include an analysis of defence industrial capabilities and features very limited assessments of future technological trends. This will limit the qualitative assessment of future equipment trends in the global power balance. Although not included in this study, these trends may very well feature in future editions of the DEO report series.

Note that all assessments of future trends in this study should be viewed as estimations based on current trends and developments, rather than exact predictions. These assessments are only relevant in the absence of major disruptive events such as war between major world powers, economic or political collapse, or another global pandemic.

Focusing on the previous ten and the coming ten years means that more long-term trends will be omitted from this report. This may impact the assessments made about the current and future power balance beyond the next decade. The study, for instance, risks underestimating the future economic and military strength of emerging economies other than China, such as India.[23] And by excluding factors such as demographics, the study also misses long-term trends such as Africa's increased share of world population.[24]

Lastly, focusing on great power competition and comparing military and economic power may invite to deterministic thinking that great power rivalry will eventually lead to conflict. However, political relationships and priorities may change quickly

[23] India is estimated to become the world's second largest economy in terms of GDP PPP in 2050, see e.g. PricewaterhouseCooper (2015) *The World in 2050 – Will the shift in global economic power continue?* February 2015, p. 3.

[24] The UN projects that the population of sub-Saharan Africa will increase from 1,066 million in 2019 (14 percent of world population) to 1,400 million in 2030 (16 percent) and 2,118 million by 2050 (22 percent), see United Nations (2019) *World Population Prospects 2019 – Highlights*, United Nations Department of Social and Economic Affairs, p. 6.

and rivalry does by no mean make conflict unavoidable.[25] Neither does it exclude cooperation in areas where great power interests align, such as combating climate change or global poverty. Great power rivalry does, however, mean that continued international tensions remain a possibility and in this context it is important to have an informed picture of the global power balance.

[25] While some historic great power rivalries, between an incumbent and emerging power, have led to conflict, other have led to compromise and eventually cooperation, see Allison, Graham (2017) *Destined for War – Can America and China Escape Thudydides's Trap?*, Scribe: London.

3 Global Power Balance

During the past decade great power rivalry has become increasingly pronounced in international affairs, most notably the heightened tensions between the US and China, the world's two largest economies and foremost military spenders. At the same time, an increasingly multipolar world has emerged where China and Russia have demonstrated increased willingness and ability to challenge the established global dominance of the US. China has reinforced its claims on most of the disputed South China Sea, including the construction of artificial islands.[26] It has also increased its military expenditure significantly between 2010 and 2019, supporting efforts to modernise its armed forces. This development has been supported by solid economic growth, albeit at lower rates than during previous decades.[27] Russia for its part has repeatedly used military means to achieve its political goals, such as the annexation of Crimea, subsequent war in Ukraine as well as military intervention in Syria. After a period of rapid military modernisation, Russian military spending has begun to decline. This is partly due to the harsher economic realities facing the country, but also because past investments have yielded tangible results in the form of improved military capabilities.[28]

Faced with this changing international security environment, the US has begun to refocus its vast military capability to better suit the purposes of great power competition, increasing its military spending in recent years. Meanwhile, several European countries have either begun to increase or stated an ambition to increase their military spending. This is in large part due to Russia's increased assertiveness, but also mounting pressure from the US to meet the NATO goal of spending 2 percent of GDP on defence by 2024. In recent years, steps towards a deepened European defence integration have also been taken,[29] although it remains to be seen what the outcome of such initiatives will be.

The following sections of this chapter will assess the global power balance in terms of military expenditure, macroeconomic trends, as well as the quantities and quality of military equipment. The next and concluding chapter will provide an assessment of future trends regarding these aspects of global power.

[26] For a more detailed discussion on the different positions regarding the South China Sea, see e.g. Hiebert, Murray; Nguyen, Phuong & Poling, Gregory B., eds. (2015) *Examining the South China Sea Disputes*.
[27] China's GDP grew 90 percent between 2010 and 2019, constant 2010 USD, which can be compared to 146 percent between 2000 and 2009, World Bank (2020a) *GDP Constant 2010 US$*. Meanwhile, military expenditure grew 85 percent between 2010 and 2019, constant 2018 USD, which can be compared to 218 percent between 2000 and 2009, SIPRI (2020a) *SIPRI Military Expenditure Database*.
[28] Oxenstierna, Susanne (2019) "The economy and military expenditure", Westerlund, Fredrik & Oxenstierna, Susanne (eds.) *Russian Military Capability in a Ten-Year Perspective – 2019*, p. 110.
[29] Most notably the Permanent Structured Cooperation (PESCO) and European Defence Fund (EDF) initiatives, both launched in 2018.

3.1 Military Expenditure

In 2019, global military expenditure amounted to a total of USD 1,868 billion, a sum which has increased by 5.7 percent during the past decade.[30] On average, the countries of the world spent 1.8 percent of their GDP on defence and defence related items in 2019. The largest geographical clusters of military spending can be found in North America, Western Europe and East Asia, see Figure 3.1.

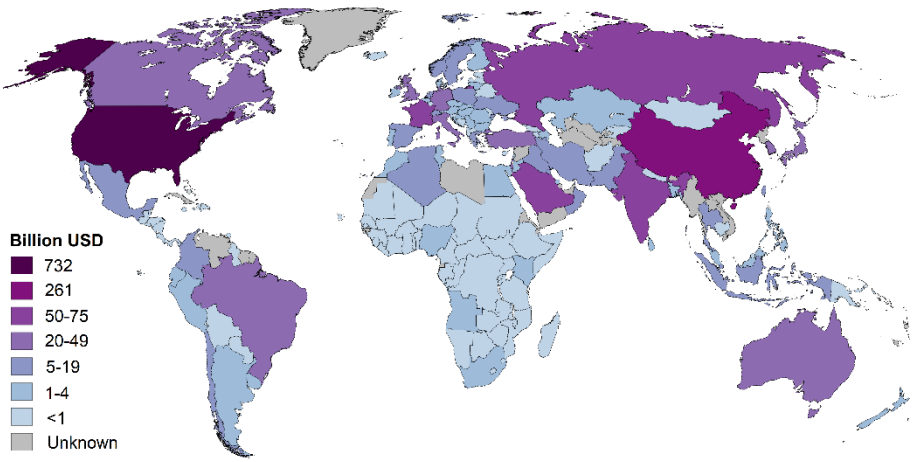

Figure 3.1: Global military expenditure, 2019 (current USD). Source: SIPRI (2020a)

The US remains the world's largest military spender by far, with military expenditure amounting to USD 732 billion in 2019. China, the world's second largest military spender, spent USD 261 billion or one-third of the US amount, the same year. India, the world's third largest spender, devoted USD 71 billion to military spending, nearly a third of China's amount. Russia allocated USD 65 billion, and Saudi Arabia USD 62 billion, towards military expenditure in 2019. For a detailed list of global military spending and the world's top 25 spenders, see Appendix A.

This illustration may seem like a familiar and long established description of the global military power balance, but much has changed during the past decade, see Figure 3.2. Despite its enduring dominance, the US share of global military expenditure has decreased notably, from 44.6 percent in 2010 to 39.2 percent in 2019. Meanwhile, China's share of world military spending has doubled, from 7.0 percent in 2010 to 14.0 percent in 2019. Russia has largely maintained its global share at 3.5 percent, while India has increased its share from 2.8 to 3.8 percent and Saudi Arabia its share from 2.8 to 3.3 percent. Meanwhile, the global share of military

[30] Note that the sum of 1,868 billion is indicated in current prices, while the 5.7 percent increase is given in constant 2018 prices, SIPRI (2020a) *SIPRI Military Expenditure Database*.

spending for the major European powers of France, the UK, Germany and Italy has decreased during the past decade, from a combined 11.3 percent to 9.3 percent.

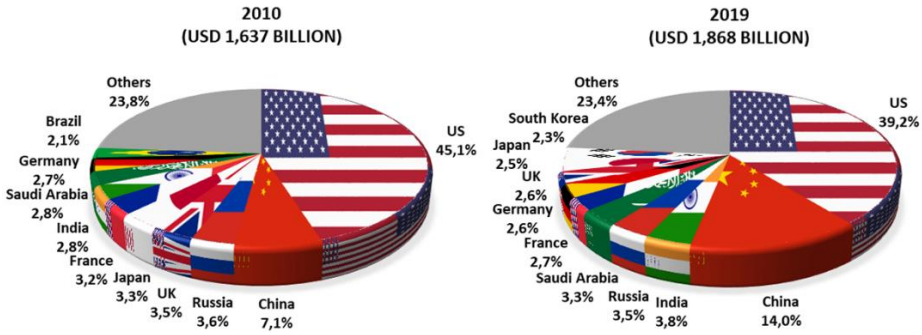

Figure 3.2: Share of global military expenditure, 2010 and 2019 (current USD). Source: SIPRI (2020a)

Even though the US and western European countries have increased their military spending in recent years, the overall trend for military expenditure between 2010 to 2019 has been a decreased global share for Western powers and an increased share for major non-Western powers. This trend can to a large extent, albeit not exclusively, be attributed to just one country, China.

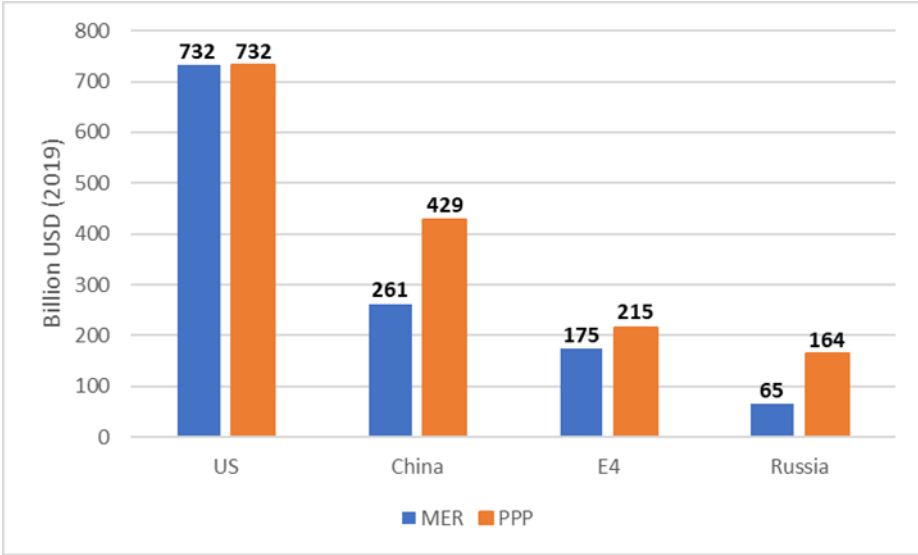

Figure 3.3: Global military expenditure in terms of market exchange rate (MER) and purchasing power parity (PPP), 2019. Source: SIPRI (2020a), OECD (2020a).

It is worth noting that the above description of military expenditure is given in USD market exchange rates (MER). However, this measure does not account for

potential differences in purchasing power between countries. When adjusting military expenditure with purchasing power parities (PPP), as seen in Figure 3.3, the relative size of China's and Russia's military expenditure increases significantly in comparison to the amounts given in terms of market exchange rates. The US level remains the same, as USD is the benchmark, while the combined expenditure of France, Germany, the UK, and Italy (E4) increases slightly when adjusted for purchasing power. This would imply that if military expenditure had a structure similar to the overall economy, and if PPP actually reflected economic activity in terms of comparable goods and services, the US global advantage in terms of military expenditure would become less pronounced than indicated by MER.

It is important to remember that PPP is not directly transferable from GDP to military expenditure, see discussion in Section 2.1. However, average wages, including those for soldiers, officers and employees within the defence industry, are lower in China and Russia compared to the US or the EU. Therefore, it would be inadvisable to completely disregard purchasing power as a relevant aspect when discussing military expenditure.

3.2 Macroeconomic Trends

Economic strength, here measured in terms of GDP, is another measure of global power. Not only does it provide economic influence in terms of consumption, production, trade and investment, it also constitutes a key prerequisite for military spending. For a detailed list of macroeconomic trends among the top 25 economies worldwide, see Appendix B.

In 2019, the US still retained its century-old position as the world's largest economy by some margin, followed by China, Japan, Germany and India. Even though this ranking may seem stable, the past two decades have seen a significant change in the global economic power balance. While the US accounted for a sizeable 24.4 percent of the world economy in 2019, the corresponding share was 30.5 percent in 2000. Meanwhile, China's share of global GDP reached 16.3 percent in 2019, up from a mere 3.6 percent in 2000. The Eurozone's share of the world economy decreased 4 percentage points during the same period, while the shares of Russia and India increased about 1 and 2 percentage points respectively.[31]

Ever since recovering from the 2008 financial crisis, major world powers such as the US, the Eurozone, China and India have all seen sustained growth rates, see Figure 3.4. Russia was the only major power to experience less stable growth rates during the past ten years, due to falling oil prices and economic sanctions by the US and the EU in the wake of the annexation of Crimea. While the world economy had begun to show signs of slowing back in 2019, following heightened international trade tensions, the coronavirus pandemic effectively ended an 11-year long

[31] World Bank (2020b) *GDP Current US$.*

period of stable global economic growth. By the spring of 2020, the pandemic had triggered the deepest economic downturn since the Great Depression of the 1930s.

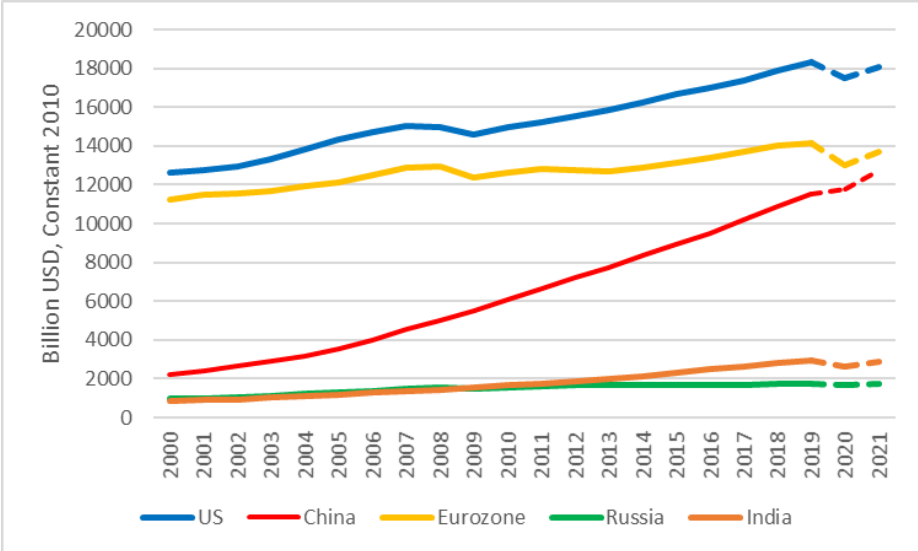

Figure 3.4: GDP of major world powers in USD (constant 2010), 2000-2021. Sources: World Bank (2020a), IMF (2020a)

Ever since it first emerged in late 2019 in Wuhan, China, the novel coronavirus has caused human suffering and wreaked economic havoc across the globe. The coronavirus pandemic had spread to other East Asian countries by February. By March the epicentre of the pandemic had gradually shifted to Europe and later to the Americas. By summer, it had reached a truly global scale, severely affecting countries in Latin America and South Asia. By November 2020, most countries were still struggling against the coronavirus and several regions were witnessing a renewed upsurge in the pandemic.

In its forecast from October 2020, the IMF predicts that global GDP will contract by 4.4 percent in 2020. The US economy is expected to contract 4.3 percent in 2020, down from an average positive growth rate of 2.3 between 2010 and 2019. Meanwhile, the Eurozone is anticipated to contract by 8.3 percent, down from 1.4 percent positive growth between 2010 and 2019. Emerging economies will not be spared the global downturn. Russia's economy is predicted to shrink by 4.1 percent and India's by 10.3 percent. China is the only major economy expected to grow in 2020, but 1.9 percent growth is still a historic low compared to the average 7.7 percent of the past decade.[32]

[32] 2020 growth rates are retrieved from IMF (2020a) *World Economic Outlook Database*. (Accessed 23 November 2020), average real GDP growth rates between 2010 and 2019 are collected from IMF (2020) *IMF Data – Real GDP growth (Annual percent change)*.

The IMF predicts a quick recovery in 2021, with a global economic growth of 5.2 percent. The US economy is expected to grow by 3.1 percent, the Eurozone by 5.2 percent, Russia by 2.8 percent, India by 8.8 percent, and China by 8.2 percent. However, such predictions must be viewed with caution, especially given the many uncertainties faced by the global economy.[33] Many risks still remain, not least the intertwined risks of a prolonged pandemic and prolonged economic recession.

While the long-term effects of the coronavirus pandemic remains to be seen, it does so far not seem to have altered the overall trends observed during the past decade. The economic power balance still seems to be shifting towards emerging economies, China in particular.

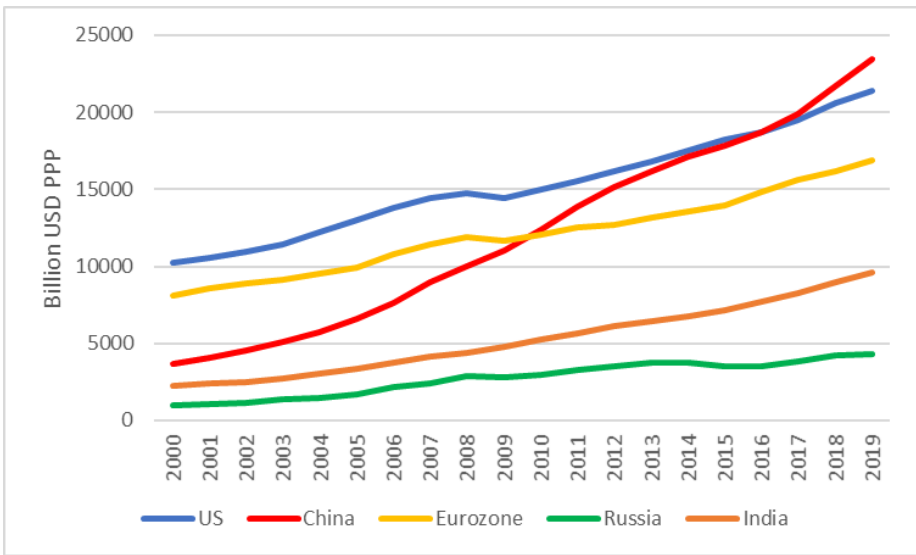

Figure 3.5: GDP of major world powers in USD PPP, 2000-2019. Source: World Bank (2020c)

This development becomes even more pronounced when GDP is expressed in terms of purchasing power. Explained above as accounting for price differences, purchasing power parity (PPP) measures the size of an economy in terms of comparable goods and services. By this measure, China has already surpassed the US to become the world's largest economy in 2016, see Figure 3.5. India's and Russia's shares of the world economy also increases significantly. When adjusted for purchasing power India becomes the world's third largest economy, up from fifth if terms of MER, overtaking Japan and Germany. Russia becomes the sixth largest economy in terms of PPP, as opposed to the eleventh in terms of MER.[34]

[33] IMF (2020) *World Economic Outlook – A Long and Difficult Ascent*, October 2020, pp. xiii-xiv.
[34] World Bank (2020c) *GDP PPP Current International US$* and World Bank (2020a) *GDP Current US$.*

As noted above, in the context of defence economics, GDP can be seen as a prerequisite for military expenditure. Military expenditure in turn is a prerequisite and input value for military capability. Military equipment can be seen as an intermediary good of sorts, between expenditure and capability. This as equipment constitutes an output of expenditure, but an input to capability. An assessment of military equipment quantities and quality may therefore add further understanding about the global power balance.

3.3 Quantities of Military Equipment

The assessment of military equipment quantities in this report focuses on big ticket items for navies, armies and air forces; such as surface combatants, submarines, armoured vehicles and artillery as well as combat aircraft, bombers and transports.

The past two decades have seen a general trend of decreasing equipment quantities over time. This is true even for countries where military expenditure has increased. The most likely explanation is that fewer platforms are needed and afforded as quality of individual weapon systems improves and unit costs increase. However, there are some exemptions to this general trend, which will be illustrated in the presentation of equipment quantities for major world powers below. For a detailed description of data and assumption together with detailed graphs and tables on military equipment quantities among major world powers, see Appendix C.

Quantities of Navy Equipment

Navy equipment quantities among the major world powers from 2000 to 2020 are illustrated in Figure 3.6. The figure shows that the US Navy has largely maintained its quantity of naval vessels during the past two decades. It has decreased its overall numbers only slightly, while increasing the number of destroyers. Meanwhile, the Chinese People's Liberation Army (PLA) Navy has undergone drastic changes, increasing the numbers of surface combatants and submarines by over 40 percent. The introduction of a new class of corvettes helps explain a sizeable share of this expansion. The E4 have decreased their combined quantity of surface combatants and submarines over the past two decades, a reduction which has been evenly distributed among vessel types. The Russian Navy has also decreased its number of naval platforms by about one fifth, mainly by reducing its large nuclear submarine fleet and to a lesser extent the number of destroyers.

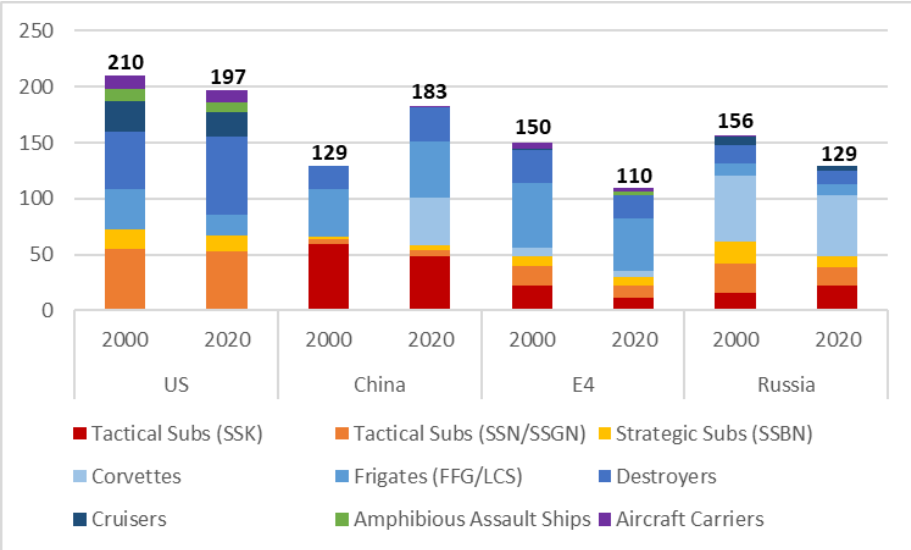

Figure 3.6: Quantity of surface combatants and submarines among major world powers. Source: IISS (2000, 2020)

While Figure 3.6 offers a comparison of the numbers of surface combatants and submarines, it does not account for the differences in size of such vessels. Surface combatants presented in the figure include everything from huge aircraft carriers and amphibious assault ships to large cruisers, destroyers, smaller frigates and even smaller corvettes. Submarines similarly include huge nuclear armed strategic submarines with nuclear propulsion, large torpedo and missile armed tactical submarines with nuclear propulsion, and smaller tactical submarines with conventional propulsion. The relative size of each navy becomes radically different when illustrating navy sizes in terms of tonnage instead of numbers of platforms.

When illustrated in terms of tonnage,[35] the US naval advantage becomes clearly visible, see Figure 3.7. The explanation for this sizeable advantage is quite straight forward, the US has far more aircraft carriers and generally larger destroyers compared to other major powers. Even though the number of US and Chinese naval vessels differs only slightly, the US Navy tonnage is more than four times larger than that of the PLA Navy. This would imply that the average US Navy vessel is about four times larger than its Chinese counterpart. On the other hand, the Chinese Navy has more than doubled its tonnage since 2000 and has roughly reached parity

[35] The tonnage for maritime vessels is expressed in terms of displacement, i.e. the amount of water displaced by the hull of any given vessel. In this report displacement tonnage for surface combatants is given in fully loaded displacement and for submarines when fully submerged. Data on tonnage have been collected from various open sources and are referred to collectively as “FOI” in Figure 3.7, see Section 2.1 for details.

with the E4 and Russia in 2020. A greater increase in tonnage compared to increase in numbers also implies that the average Chinese naval vessel has become larger.

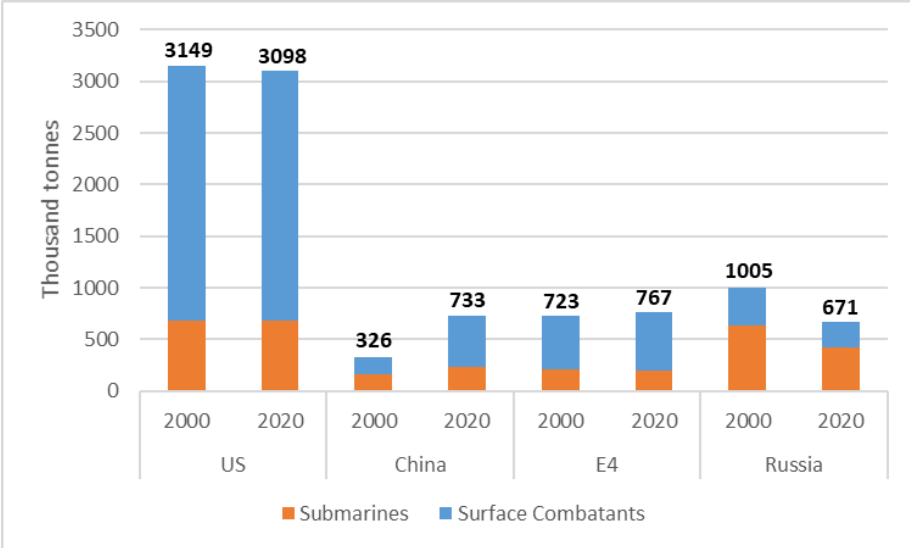

Figure 3.7: Tonnage of surface combatants and submarines among major world powers. Source: IISS (2000, 2020), FOI

The E4 have increased their combined tonnage during the past two decades, even as the number of vessels has decreased, implying that the average E4 navy vessel has become larger. Meanwhile, Russia decommissioned several large surface combatants and nuclear submarines during the 2000s, causing naval tonnage to decrease sharper than the number of vessels during the past twenty years. Note, however, that a sizeable portion of this change is caused by the temporary inactivation of the aircraft carrier Admiral Kuznetsov due to long-term overhaul. Tonnage may be a crude measure, but not irrelevant with regard to naval capabilities, as larger vessels provide more space for armament,[36] sensors and other electronic hardware. On the other hand, even smaller missile armed vessels can provide significant lethality to a navy. Therefore, neither the number of vessels nor the total tonnage should be seen as the better measure, instead these aspects complement each other when quantifying and comparing major world power navies.

Quantities of Army Equipment

Army equipment quantities have developed in different directions during the past two decades. Generally, the quantity of main battle tanks (MBTs) and artillery pieces and multiple launch rocket systems (MLRSs) has decreased among the major world powers. Meanwhile, the numbers of infantry fighting vehicles (IFVs)

[36] Note that there seems to be a correlation between total tonnage and the number of missiles carried, see e.g. Table E.6 in Appendix E of this report.

and armoured personnel carriers (APCs) have either increased in absolute terms or been maintained to a higher degree than tanks and artillery. These trends are clearly visible among the major world powers, see Figure 3.8. The figure also shows that in 2020, the US had a numerical advantage in terms of IFVs and APCs, while China had an advantage in terms of tanks and artillery.

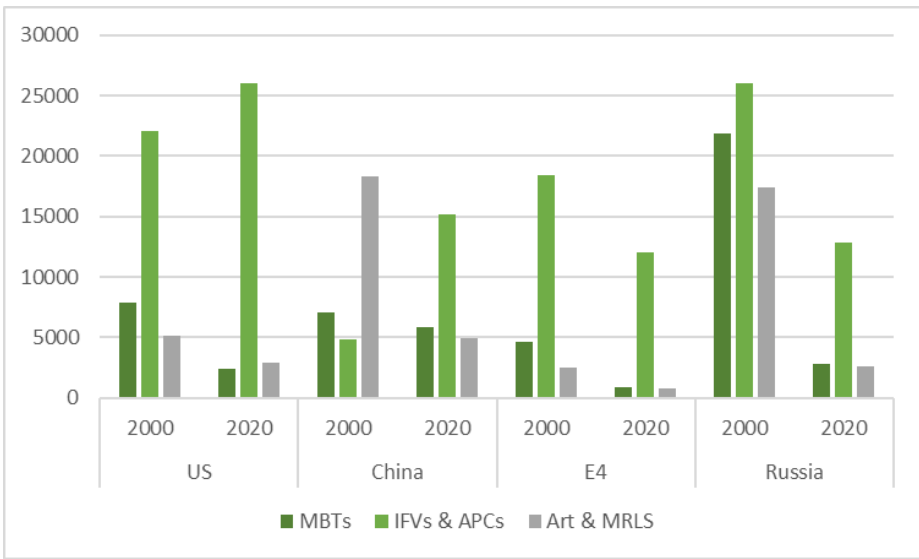

Figure 3.8: Quantity of army equipment among major world powers. Source: IISS (2000, 2020)

The US Army has reduced its quantity of tanks in active service by two-thirds between 2000 and 2020, but still maintains a sizeable amount in reserve. In 2020, the Chinese PLA had the world's largest number of main battle tanks in active service. However, in spite of rapid modernisation, one-third of China's tanks still consists of outdated types. During the past two decades, the armies of France, Germany, the UK, and Italy have decreased their tank numbers drastically. The E4 has kept less than one-fifth of their combined tank force in active service in 2020 compared to 2000. Russia has also decreased the number of tanks by seven-eighths since 2000. Nevertheless, Russia still has more than three times the number of tanks in active service compared to the E4 combined. Russia also maintains a huge number of tanks in reserve, although it is unclear how many of these could actually be made operationally available.

The numbers of IFVs and APCs have increased in the US Army, especially wheeled APCs which were favoured in the 2000s and 2010s because of their lower weight and easier deployment abroad. In 2020 the US had nearly twice the number of IFVs and APCs than any other major power. China has also increased the number of IFVs and APCs in an effort to modernise its army, but still has relatively

few infantry support vehicles compared to the US.[37] Both the E4 and Russia have decreased their number of IFVs and APCs, but still maintain these vehicle types to a much greater extent than tanks and artillery.

All major world powers have decreased the number of artillery pieces and MLRSs, gradually phasing out towed artillery in favour of more capable self-propelled systems. The US Army has decreased its number of artillery pieces by almost half between 2000 and 2020. While the reduction of artillery in China has been even more pronounced, the PLA still has the largest quantity of artillery in active service among the major world powers. The E4 had cut its number of artillery pieces in 2020 to one-third of their combined force in 2000. The reduction of artillery in Russia was even more drastic, to less than one-sixth of its numbers in 2000 by 2020. Russia does maintain over 16,600 artillery pieces and MLRS in reserve, although their exact availability is not clear.[38] Although the reductions of artillery quantities are comparatively large in China and Russia, these countries still possess a numerical advantage over the US and the E4 respectively.

Quantities of Air Force Equipment

The quantities of combat aircraft have decreased among all major world powers during the past two decades, see Figure 3.9.

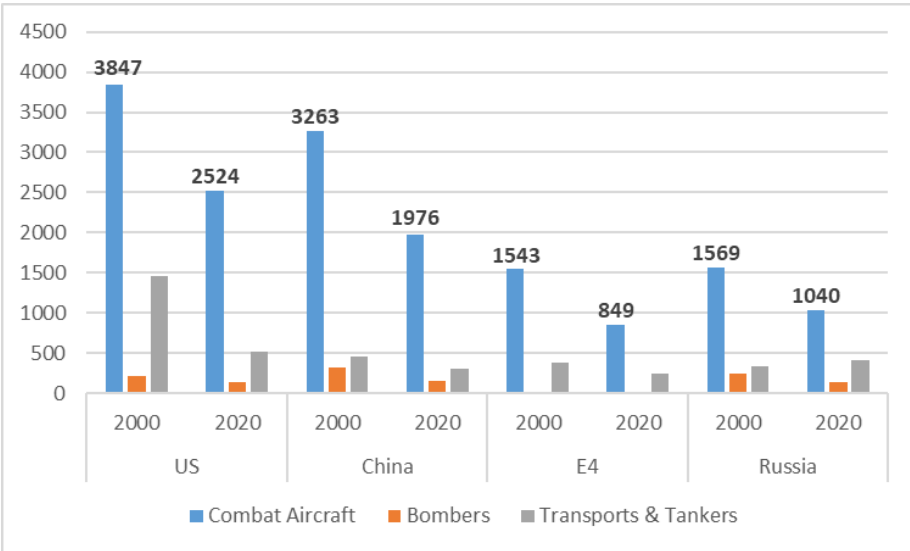

Figure 3.9: Quantity of aircraft among major world powers. Source: IISS (2000, 2020)

[37] While the US had 26,000 IFVs and APCs for an army of 481,750 men in 2020, China had 15,200 for an army of 975,000 men, IISS (2020) *The Military Balance 2020*.
[38] IISS (2020) *The Military Balance 2020*.

This trend could likely be attributed to the choice of quality over quantity as individual platforms have become more advanced and more expensive. The US has maintained a clear numerical advantage over other major world powers in terms of combat aircraft. China has the second largest combat aircraft fleet. Meanwhile, Russia fielded more combat aircraft in 2020 than the E4 air forces combined.

In terms of transport aircraft the US also maintains a significant advantage. And although China has more bombers, most are of older designs and not equivalent in terms of capability to their US counterparts. The E4 have no purpose-built bombers, instead relying completely on multirole combat aircraft. Similarly to China, Russia still relies on older Soviet designs which have been upgraded, but not replaced, as of 2020. The US also has a numerical advantage in terms of transport aircraft, which are generally larger than Russian, European or Chinese equivalents.

Quantities of Military Equipment, Overall

Overall, the US has maintained its quantitative edge in the air and at sea, while the power balance on land remains more mixed. The US dominance in the air remains solid. However, the Chinese PLA Navy has significantly narrowed the numerical gap to the US, while overtaking the E4 and Russia by the same metric during the past two decades. China has gained a numerical advantage in terms of tanks, but the US has maintained and even widened its advantage in terms of IFVs and APCs. Meanwhile, China still has a numerical advantage in artillery over the US and Russia over the E4, in spite of the fact that both China and Russia have reduced artillery numbers more drastically between 2000 and 2020.

Although China only spent about one-third on its military in 2019 compared to the US, it has almost 80 percent the number of combat aircraft and nearly the same amount of naval vessels. Similarly, while Russia spends only slightly more than France, it has more submarines, tanks and combat aircraft than the four major European powers combined. This could indicate that there is some merit to the idea that China and Russia have greater purchasing power even when it comes to military hardware, and that they as a consequence get larger quantities of equipment out of their military expenditure than for instance the US and the E4.

However, equipment quantities do not tell the whole story. As seen above, the US Navy is still unrivalled in terms of tonnage. This allows for, among other things, more space for weaponry and sensors, which in turn may differ in capability. Furthermore, the average Chinese or Russian combat aircraft may not display the same performance as its US counterpart. European equipment may also have a qualitative edge over Chinese and Russian dittos. Therefore, in order to give a more complete assessment of the current global power balance, there is a need to look closer at quality indicators for military equipment.

3.4 Quality of Military Equipment

The analysis of military equipment quality in this report begins with a categorisation according to modernity, where key navy, army and air force equipment are classified as either modern, intermediate or legacy, or by generation. However, as the quality of modern equipment may also vary quite significantly, this broad categorisation is complemented by a series of quality indicators for key equipment within each service branch; surface combatants, main battle tanks and combat aircraft. For a detailed description of methods and assumption together with more detailed graphs and tables on equipment quality, see Appendix D.

Quality of Navy Equipment

Surface combatants are categorised on the basis of which year the lead or first ship of the class was commissioned. The category modern includes all ship classes which have been taken into active service from 1990 and onwards, intermediate between 1970 and 1989, while legacy comprises classes taken into service before 1970. However, there are some exemptions to this general rule.[39]

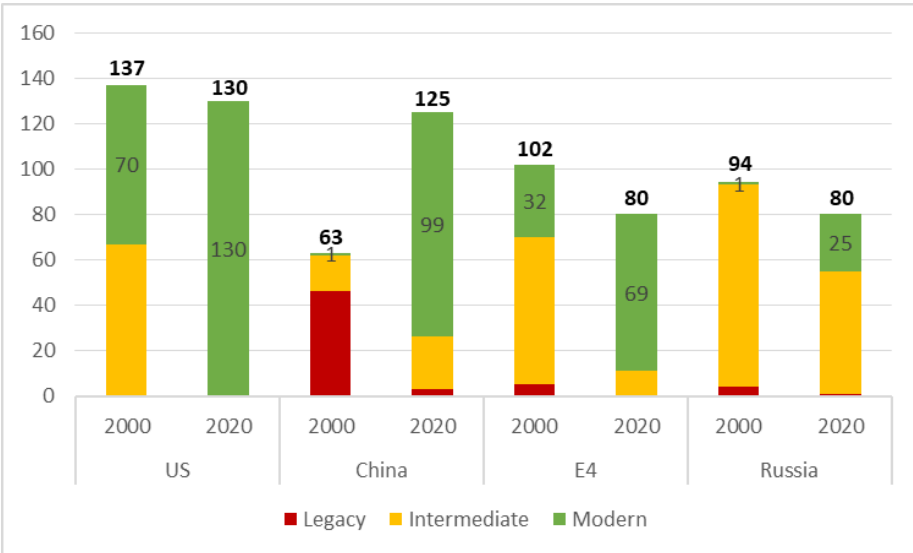

Figure 3.10: Surface combatants by generation among major world powers. Source: IISS (2000, 2020)

According to the categorisation of this report the US Navy surface combatant fleet in 2020 could be considered fully modernised, see Figure 3.10. Meanwhile, China has added modern surface combatants at a rapid pace, from just one in 2000 to 99

[39] The equipment of the Chinese PLA Navy is the main exemption. As China was late to develop an indigenous modern arms industry, vessels taken into active service from 2000 and onwards is classified as modern, intermediate between 1980 and 1999, and legacy from before 1980.

in 2020. The combined surface fleet of the E4 is almost entirely modern with 69 out of 80 belonging to classes where the lead ship was commissioned after 1990. Meanwhile, the Russian Navy still relies heavily on upgrading vessels commissioned during the 1980s as shipbuilding has been slow to recover after the fall of the Soviet Union, only in the late 2000s did new ship classes begin to enter service.

Table 3.1: Selected modern surface combatant performance among major world powers, 2020. Source: IISS (2020), FOI.

Class (Country)	No. Missiles	SAM Range/ Speed	ASM Range/ Speed	ASW TT/ Hel.	Quant. 2020 No./Type
Ticonderoga (US)	130	240/3.5	240/3.5	6/2	22/22
A. Bourke IIA (US)	96	240/3.5	240/3.5	6/2	39/69
Freedom (US)	-	-/-	-/-	-/2	9/19
Type 055 (China)	112	150/4.2	540/*3.0	6/2	1/31
Type 052D (China)	64	150/4.2	540/*3.0	6/1	11/31
Type 054A (China)	40	40/3.0	180/0.9	6/1	30/50
Type 056/A (China)	4	-/-	180/0.9	6/-	43/43
Forbin (France)	56	100/4.5	180.0.9	4/1	2/11
Sachsen (Germany)	40	170/3.5	120/0.9	6/2	3/10
Type 45 (UK)	56	100/4.5	240/0.9	4/1	6/6
Type 23 (UK)	40	10/2.0	240/0.9	4/2	13/13
Andrea Doria (Italy)	56	100/4.5	180/0.9	2/1	2/12
Gorshkov (Russia)	48	150/6.0	300/2.4	8/1	1/10
Grigorovich (Russia)	32	50/4.0	300/2.4	4/1	2/10
Steregushchiy (Ru.)	20	50/2.6	130/0.8	8/1	6/43

* The YJ-18 ASM has a flight speed of Mach 0.8 and terminal attack speed of Mach 3.0.

Differences in quality indicators among modern surface combatants are listed in Table 3.1.[40] Note that the table only includes a handful of ship classes for each of the major powers and does not include aircraft carriers or amphibious assault ships. The quality indicators listed include the maximum number of missiles carried, the maximum range and speed of surface-to-air-missiles (SAMs) and anti-ship missiles (ASMs). Note that the values for range and speed refer to the best available missile in each category, which is not necessarily the most commonly available. Maximum missile range is indicated in kilometres and speed in terms of Mach. Indicators also include anti-submarine-warfare (ASW) metrics such as the number of torpedo tubes (TT) and number of helicopters carried. The 2020 quantities for each ship class (e.g. 39 Arleigh Bourke IIA destroyers) and total number of that ship type (e.g. 69 US destroyers) are also included in order to give a sense of how common certain capabilities are.

Modern surface combatants feature several common traits. They generally have some degree of stealth incorporated into their design and often come equipped with

[40] The number of missiles, torpedoes, helicopters and vessels are obtained from IISS (2020), complemented by missile ranges and speeds from various institutes or online sources. These complementary data are referred to collectively as "FOI" in Table 3.1. Note that short-range point-defence missiles are not included in the missile tally, neither as separate launchers or as quad-packed in missile launch cells.

advanced radar and sonar. All of the ship classes included in Table 3.1 also carry at least one multi-purpose main gun and a number of close-in-weapon-systems (CIWS) for short range defence. Although the ships vary in range and endurance, their top speeds are generally around 30 knots.

Modern US surface combatants, such as the Ticonderoga class cruisers and Arleigh Bourke class destroyers, are generally larger and capable of carrying more missiles than their international counterparts. Some of China's most modern platforms, such as the Type 055 and Type 052D destroyers, have reached similar sizes and missile carrying capabilities as their US or E4 equivalents respectively. However, such destroyers do not make up the bulk of the PLA Navy's modern inventory, which instead largely consists of more lightly armed Type 054A frigates and Type 056 corvettes.

The modern destroyers and frigates of the E4 navies are generally in the mid-to-large range of surface combatants. UK Type 45 destroyers are small compared to US ones but German Sachsen frigates are large compared to their Chinese counterparts. Russian Admiral Gorshkov frigates are roughly the same size as their German counterparts, while the Admiral Grigorovich class is smaller and has fewer missiles. Meanwhile, the Steregushchiy class is relatively large and well-armed compared to corvettes of other navies. There are several other factors in assessing surface combatant performance than just armament, but this brief overview does give some insights.

US surface combatants seem to have a clear advantage in terms of anti-air with longer ranged surface-to-air missiles and numbers of helicopters carried, providing robust surveillance and ASW capabilities. By the same logic, China and Russia have an advantage over the US and E4 in terms of surface warfare, possessing longer ranged high-speed anti-ship missiles. However, it is worth noting that US surface combatants often operate in carrier groups allowing carrier-based aircraft to carry anti-ship missiles well beyond the range of any ship-launched missile. France, the UK and Italy also operate carriers and could use similar tactics.

Quality of Army Equipment

Main battle tanks constitute the heavily armed and armoured spearhead of modern mechanised army formations. In this section, tanks are categorised according to modernity by generation. First generation main battle tanks were introduced in the late 1940s, second generation in the 1960s and modern third generation tanks from the 1980s and onwards. The US Army has reduced the size of its exclusively third generation tank force to 2,414 Abrams tanks, but it keeps an additional 3,300 Abrams in reserve, see Figure 3.11. China has the world's largest tank force in active service, and the second largest inventory of third generation tanks, which include the modern Type 99A and Type 96A. However, one-third of the PLA tank force still consists of the obsolete Type 59 legacy tanks.

The E4 possess modern but very small tank forces, only around 200 per country. These include the French Leclerc, German Leopard 2, the UK Challenger 2 and the Italian Ariete. Russia has the world's largest inventory of third generation tanks which mainly consist of upgrades of Soviet era designs such as the T-72B3 or modern derivatives such as the T-90. Russia also has the world's largest tank reserve force, over 10,000 in storage, though availability may vary.

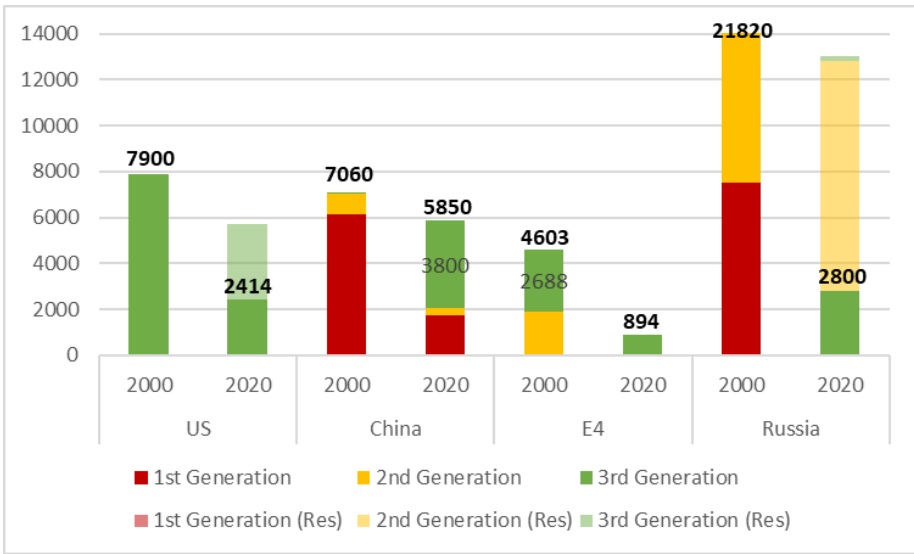

Figure 3.11: Main battle tanks by generation among major world powers. Source: IISS (2000, 2020)

Main battle tank performance can be described as a combination of firepower, protection and mobility. In Table 3.2 the firepower for a given tank is measured by the penetration depth of the best available kinetic projectile from a distance of 2,000 metres, indicated in millimetres of rolled homogenous armour equivalents (RHAe), i.e. steel equivalents. Similarly, armour is indicated by the protection against kinetic penetrators at the front of the turret, usually the strongest protected area of a tank, also in millimetres RHAe.[41] Mobility values are measured by horsepower through tonnes. Note that the values presented in the table have been collected from open sources and should be seen as estimates rather than exact truths.

The quality indicators in Table 3.2 shows that the US M1A2 Abrams has a slight edge in terms of firepower, compared to other third generation tanks. On paper, China's most modern tank, the Type 99A, is on par with its Western counterparts.

[41] As modern main battle tank armour usually consists of composite armour, reactive armour or both, protection levels are usually converted into an expressed as millimetres of rolled homogenous steel equivalents, i.e. how much steel the composite or reactive armour is equal to.

It also features a laser dazzler active protection system against anti-tank missiles. However, the far more common Type 96A is less capable than its larger cousin.

Table 3.2: Selected modern main battle tank performance among major world powers, 2020. Source: US Training and Doctrine Command (2014), Steelbeast.com, IISS (2020).

Type (Country)	Gen.	Firepower (mm RHAe)	Armour (mm RHAe)	Mobility (HP/ tonne)	Quantity 2020
M1A2 Abrams (US)	+3	840	950	23.1	1605
M1A1 Abrams (US)	3	750	600	25.9	775
ZTZ- 99A (China)	+3	800	990	25.9	500
ZTZ-96A (China)	-3	660	780	18.6	1500
Leclerc (France)	3	690	890	26.6	222
*Leopard 2A6 (Ger.)**	+3	750	970	24.0	225
Challenger 2 (UK)	+3	610	1250	19.2	227
T-90A (Russia)	3	660	840	23.7	350
T-72B3 (Russia)	-3	660	780	18.9	1350

* Data actually represent the older Leopard 2A5 version, exported to e.g. Denmark and Sweden.

European tanks generally perform well. The German Leopard 2A6 is a well-balanced platform, versions of which have been exported to several countries. The UK Challenger 2 is the world's best protected tank. The French Leclerc is not as heavily armed or armoured, but more mobile than the other two European tanks. Modern Russian tanks, while not quite on par with US or German tanks, have undergone several improvements, and the T-90A and T-72BM are far superior to, for instance, the T-72Ms employed by Saddam Hussein's Iraq during the Gulf War. Furthermore, Russian third generation tanks feature both hard kill and soft kill active protection systems which are not yet standard on US or European tanks.[42]

Quality of Air Force Equipment

The US Air Force's advantage in terms of quantity becomes even more apparent when accounting for modernity, see Figure 3.12. Having pioneered fifth-generation fighters back in the 1980s, the US has held a virtual monopoly on operating such aircraft until the 2010s. China has come a long way during the past decades, fielding over a thousand fourth generation combat aircraft and having begun to introduce fifth generation aircraft. However, China still operates several types of older aircraft and has yet to catch up to the other major powers in terms of aircraft development, not least when it comes to developing strong domestic turbofan jet engines. While the UK and Italy have bought American F-35s, the E4 have not developed their own fifth generation fighters, instead choosing to upgrade fourth generation aircraft. The E4 also operate several third generation aircraft. Russia is set to introduce fifth generation combat aircraft in the near future, but these are not

[42] See e.g. Olsson, Per (2018) *Towards a Tool for Measuring Military Performance*.

yet classified as being in active service and Russia currently relies heavily on various fourth generation combat aircraft. The Russian air force also operates several third generation aircraft.

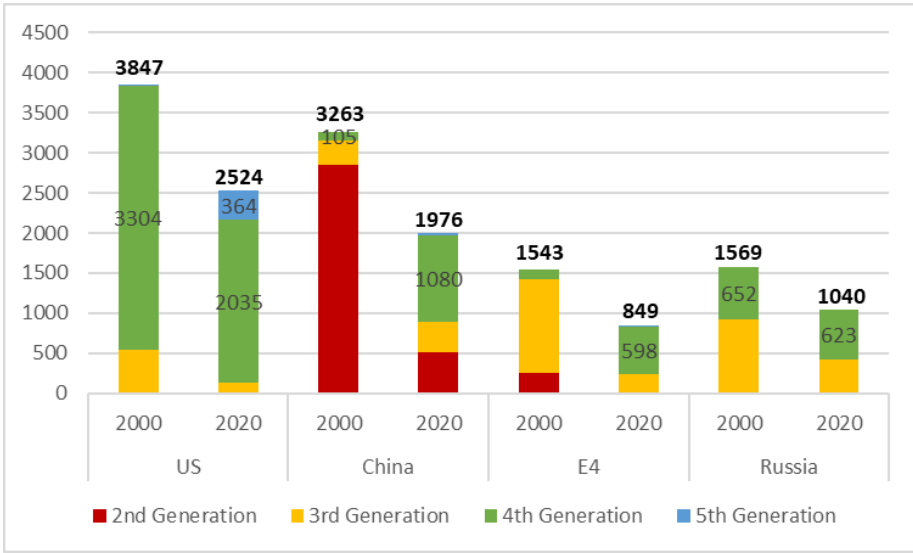

Figure 3.12: Combat aircraft by generation among major world powers. Source: IISS (2000, 2020)

Combat aircraft performance is assessed through the number of hard points, i.e. stations for missiles, bombs or additional fuel tanks, combat range (in km) and maximum speed (in km/h). The generation of the aircraft, fifth or fourth, is also presented as a proxy performance indicator. Fifth generation combat aircraft combine stealth, i.e. radar absorbent materials, minimised radar cross-section and IR-signature, with high manoeuvrability and advanced avionics.

Table 3.3: Selected modern combat aircraft performance among major world powers, 2020. Source: IISS (2020), FOI.

Type (Country)	Gen.	No. Hard-points*	Range (Km)	Speed (Km/h)	Quant. 2020
F-35A (US)	5	10(4)	1667	1960	316
F-22 (US)	5	12(8)	>3000	2470	159
F-16 (US)	4	11	3333	2205	553
F-15E (US)	+4	11	3840	3018	210
J-20 (China)	5	10(6)	3400	2100	22
J-10 (China)	4	12	3000	2450	445
Rafale (France)	+4	14	3125	2205	100
Eurofighter (UK/G/It)	+4	13	3790	2470	377
Su-35 (Russia)	+4	12	3600	2390	90
Su-27 (Russia)	4	10	3680	2879	119

* Number of missiles carried internally marked with parenthesis.

The aforementioned US advantage may not seem immediately evident from looking at Table 3.3.[43] Most aircraft seem to perform in the same range, and if anything the US F-35 seem to underperform. However, it is worth remembering that the F-35 is a single-engine fifth generation stealth aircraft while most others aircraft in the table are twin-engine. The US F-16 and Chinese J-10 are also single engine, but non-stealth fourth generation.

When instead trying to find the most relevant comparisons, such as the US F-22 and the Chinese J-20, it is clearer that the Chinese fifth generation aircraft is unable to carry the same amount of missiles or reach the same speed.[44] And when comparing twin-engine air-superiority fighters like the Russian Su-35 and Su-27 with their US counterpart, the F-15E, the US aircraft also performs slightly better. E4 combat aircraft generally perform quite well in an international comparison. It is worth remembering that several vital performance factors, such as avionics, stealth capabilities and capabilities of individual missiles, are not included in the assessments of this report. However, when comparing combat aircraft with similar mission sets and design purposes, it seems that the US continues to enjoy a clear advantage in the air.

The indicators used in this report do not constitute a comprehensive analysis of equipment quality. And even if they did, any assessment of equipment quality would not be the same as an estimate of overall military capability. Modernisation of equipment needs to be followed by an upgrade in training, tactics, doctrine and leadership, otherwise the equipment is just expensive chunks of alloys and composites. Nevertheless, taken together with military expenditure and equipment quantity, the assessment of equipment quality presented above does provide an added perspective to the current global power balance. The following chapter will examine how this power balance may develop in the coming decade.

[43] Data on aircraft generations, number of hardpoints, range and speed, are obtained from various open sources, referred to collectively as “FOI” in Table 3.3, see Section 2.1 for details.

[44] The exact range of the F-22 could not been determined by this study and is therefore not compared with that of the J-20. Although the J-20 seems to have a larger body, which could allow for more fuel, the engine fuel-efficiency is also a determinant of range.

4 Future Trends

The relationship between the US and China, which has been tense for years, deteriorated rapidly during 2020. The two countries, engaged in a trade war since 2018, have exchanged harsh criticism of each other's response to the coronavirus pandemic. The US has also criticised China's human rights record and declared its maritime claims in the South China Sea to be unlawful. China for its part has dismissed such critique as attempts to contain and vilify it. China has also accused the US of protectionism and of destabilising the security environment in East Asia by increasing its support for Taiwan. These developments could significantly worsen the ongoing trade dispute between the world's two largest economies and the US has already implemented or threatened to implement a number of sanctions against Chinese officials and entities. Further escalation of US-China tensions could have repercussions far beyond the borders of the two countries and delay or derail the global post-pandemic economic recovery. While currently centred on specific political issues, the rivalry between the US and China also features more structural elements. Most importantly, the changing global power balance of the past decade, observed in the previous chapter.

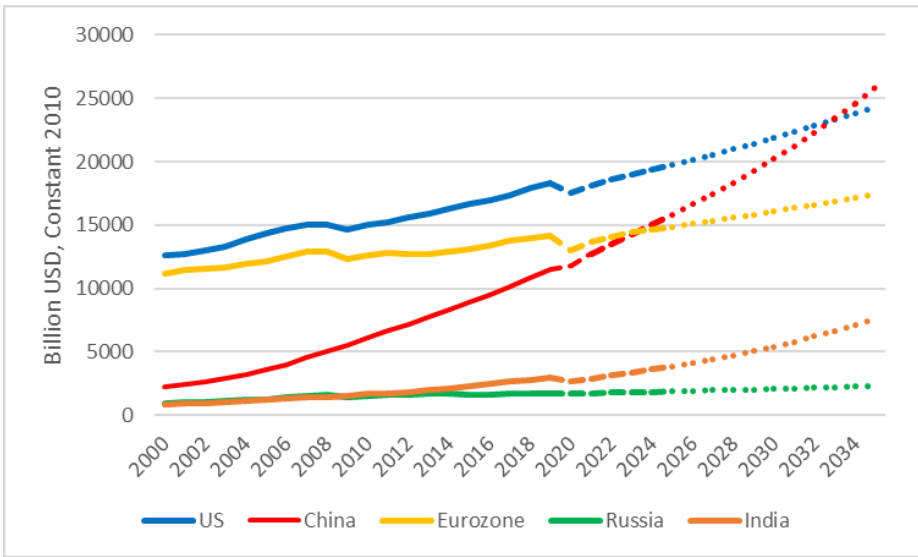

Figure 4.1: GDP of major world powers in USD (constant 2010), 2000-2035. Sources: World Bank (2020a), IMF (2020a), CBO (2020), World Bank (2013)

Assuming that China's economic growth will gradually slow to about 5 percent by 2030,[45] while acknowledging that this is not predetermined in any way, China is

[45] The assumption of Chinese growth rates gradually slowing to 5 percent is based on projections by the World Bank (2013) *China 2030: Building a Modern, Harmonious, and Creative Society*. This estimate

set to surpass the US as the world's largest economy in terms of nominal GDP around 2030, see Figure 4.1. If realised, this development would likely put further strain on the bilateral relationship between the world's two most powerful nations, increasing the risk of emboldened actions by China as well as an increasingly severe response from the US. It could also increase the risk of misunderstandings and miscalculations regarding each other's intentions and capabilities.

In this report the assumed macroeconomic power shift is estimated to occur in 2033. However, as values are indicated in USD, the precision of this assessment is vulnerable to changes in the relative currency value of the USD and the Chinese RMB. It is also worth remembering that in terms of purchasing power parity the shift already occurred in 2016, and forecasts by OECD estimate that China's PPP-adjusted GDP will be 67 percent larger than that of the US by 2030.[46]

The Eurozone is expected to start recovering from the pandemic from 2021 and onwards.[47] However, assuming that the growth rate of the previous decade will continue into the next, the Eurozone is estimated to grow somewhat slower than the US. Between 2022 and 2025, the economies of the Eurozone and Russia are expected to increase by 1.6 and 2 percent respectively. If anything, this may seem to be slightly advantageous for Russia. However, given that the size of the Eurozone economy is several times larger, the absolute economic gap between the Eurozone and Russia is actually likely to increase in favour of former.

Similarly, India's economic growth rate could very well surpass that of China in the coming decade, as the Chinese growth rate gradually slows.[48] But again, given the differences in economic size between the Asian giants, the absolute gap will persist during the coming decade. It is even likely to increase, as 5 percent growth adds far more value to a USD 14 trillion economy than 7 percent does to a USD 3 trillion economy.

However, the future is not set in stone. Economic forecasting is difficult at the best of times and the coronavirus pandemic has made predictions about the future even more uncertain. For a detailed description of the data and assumptions concerning future macroeconomic trends in this report, see Appendix E.

The future military expenditure among major world powers will depend on at least two factors, the economic development of each country and the priority each country gives to military expenditure as share of GDP. Assuming for the moment,

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is fairly mainstream, but not uncontested. Sceptics about China's future growth prospects cite high debt, a shrinking workforce and increasingly difficult productivity gains as reasons why China's growth may be significantly lower. Nevertheless, PricewaterhouseCooper (2015) *The World in 2050 – Will the shift in global economic power continue?*, estimate that China's economy will surpass that of the US in terms USD MER in 2027, p. 11.

[46] OECD (2020) *GDP Long-Term Forecast*. (Accessed 29 October 2020).

[47] IMF (2020a) *World Economic Outlook Database*. (Accessed 23 November 2020).

[48] See e.g. PricewaterhouseCooper (2015) *The World in 2050 – Will the shift in global economic power continue?*, p. 8.

though in reality unlikely, that the military expenditure share of GDP would remain the same for all countries in 2030 compared to 2019. In this hypothetical scenario, the US would still devote 1.7 times more than China to military spending even if their economies were to reach equal size in terms of MER. This as the US spends a larger share of GDP on its military, 3.4 percent, compared to China's 1.9 percent. In other words, if China wishes to close the military expenditure gap further by the 2030s, it has to increase its military spending as share of GDP. Similarly, if India were to continue spending 2.4 percent of its GDP on military spending it would spend one-third as much as China, even if the Chinese economy was 3.7 times larger in 2030. Furthermore, the Eurozone is likely to outpace Russia in terms of military spending in the coming decade, given the differences in economic size. This of course, provided that their respective military spending as share of GDP does not alter significantly.

The future trends for military equipment will depend on both macroeconomic conditions, level of military spending, what priority they give or can give to investments in equipment and what priority each country gives to the respective branches of their armed forces. For a detailed list of future quantities and a description of the underlying assumptions, see Appendix E.

Concerning the future quantities of major world power naval equipment, projections until 2025 are fairly straight forward. This as most of the ships likely to be in service by then have either been launched or were in the final stages of construction in 2020. Projections until 2030, however, have required a higher degree of estimation and sometimes informed guesswork based on reasonable assumptions. Furthermore, estimates after 2025 are far more susceptible to revisions in the economic aftermath of the coronavirus pandemic.

The US currently plans for a navy consisting of 355 ships by 2034, reaching 325 by 2030, counting all vessels including support ships. The US naval plan has been subject to several revisions and the feasibility of the 355-plan is highly uncertain. However, if assuming that these ambitions actually were to be realised, the plan would translate into 163 surface combatants and 56 submarines by 2030. According to the latest version of the 355-ship plan, this force would include 10 aircraft carriers, 104 cruiser and destroyers, 43 future frigates and littoral combat ships, 12 strategic and 44 attack submarines as well as several amphibious, logistical and support ships.[49] Regardless of the implementation of this exact plan, the US Navy will still enjoy a quantitative advantage over other major powers in terms of aircraft carriers and large surface combatants by 2030. Even though the number of nuclear submarines are likely to decrease, the US current advantage is large enough to keep it in a numerical lead with regard to these types of vessels.

[49] Congressional Research Service (2020) *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, September 2020, RL32665, pp. 6-7.

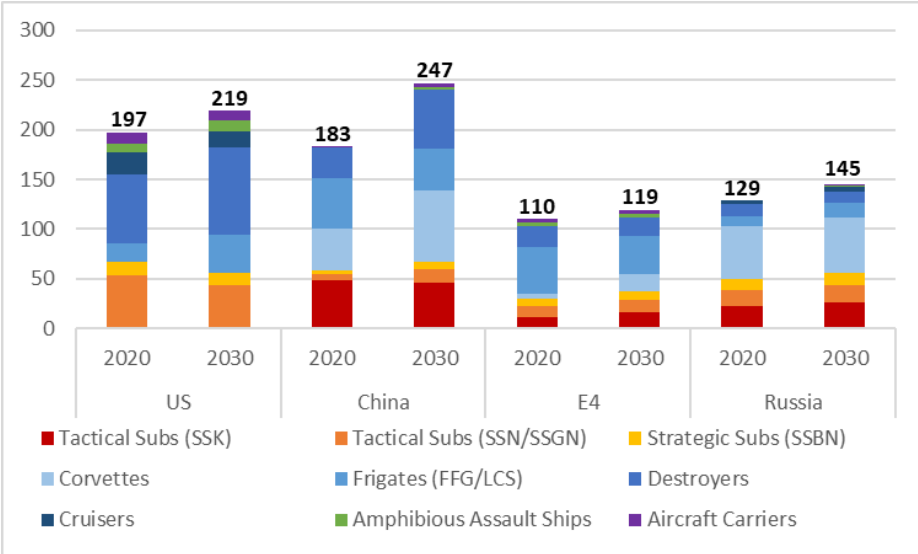

Figure 4.2: Future naval equipment among major world powers, 2020-2030. Source: IISS, FOI

The Chinese PLA Navy is almost certain to continue its rapid expansion during the following decade, see Figure 4.2.[50] By 2030, the Chinese navy is estimated to have 180 surface combatants and 67 submarines. The majority of these vessels have already been constructed and are likely to enter service by 2025. After 2025, however, this study assumes that the rate of expansion will slow. This due to increased maintenance costs, incurred by the larger and more modern fleet, coupled with a likely slower growth in military expenditure. Nevertheless, China will put increased emphasis on constructing large surface combatants in the coming decade, including two additional aircraft carriers, a number of amphibious assault ships, several destroyers and a series of nuclear submarines. Taken together these additions would significantly increase the PLA Navy's ability to project power and strengthen its regional advantage in East Asia. Furthermore, it will gain an overall numerical advantage over the US Navy in the years leading up to 2030.

The navies of France, the UK, Germany and Italy are likely to expand slightly in size until 2030. This would mean a reversal of the downward trend from previous decades. The combined navies of the four European powers is estimated to consist of 82 surface combatants and 37 submarines in 2030. However, the number of large surface combatants are assumed to decrease slightly as older classes of French and Italian destroyers are nearing the end of their life-cycle without any immediate replacements planned to enter service before 2030. Furthermore, new

[50] Data on future naval equipment are obtained from wide range of open sources and referred to collectively as "FOI" in Figure 4.2, see Section 2.1 for details.

French, German, UK and Italian frigates will not fully replace older classes on a one-to-one basis. The majority of the estimated increase can instead be attributed to the growing number of German and Italian corvettes. The quantity of submarines will also increase slightly as new French, German, UK and Italian submarines replace older classes.

The Russian navy is estimated to increase its overall number of vessels. This study estimates that the Russian Navy will have 89 surface combatants and 56 submarines by 2030. This increase includes nearly every type of ship and submarine, but most new ships will consist of smaller surface combatants. This may be difficult to discern from Figure 4.2, but the stable number of corvettes hides the fact that a large number of older vessels, will be replaced by new ones. Similarly, new frigate classes are set to replace older ones. Larger surface combatants will continue to consist of updated Soviet era cruisers, destroyers, and one refurbished aircraft carrier. The new class of large destroyers, previously planned, now seems to be postponed indefinitely.[51] The only exception when it comes to new large surface combatants is a newly produced class of amphibious assault ships. The quantity of submarines is likely to increase somewhat as older conventional submarines are replaced by newer classes and further nuclear submarines are being introduced. The number of strategic nuclear submarines is likely to increase slightly by 2030, while older classes are replaced.

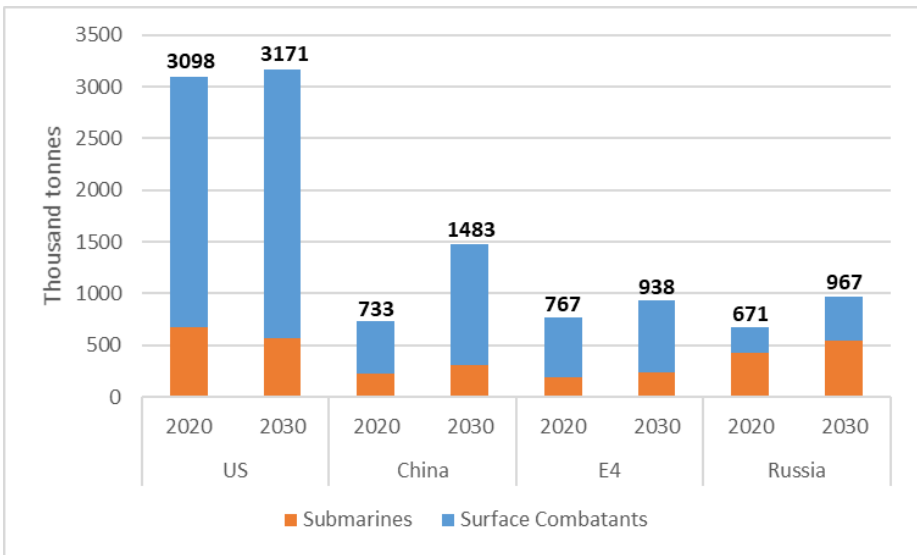

Figure 4.3: Future naval tonnage among major world powers, 2020-2030. Source: FOI

[51] Trevithick, Joseph (2020) "Russia Has Abandoned Its Massive Nuclear Destroyer and Supersized Frigate Programs", *The Drive*, 21 April 2020. (Accessed 23 November 2020).

In terms of tonnage, the naval balance will also change during the coming decade, see Figure 4.3. If the estimates above hold, the PLA Navy will continue to narrow the tonnage gap, from one-fourth of total US Navy tonnage in 2020 to nearly half by 2030. With 60 percent of the US Navy currently located to the Pacific theatre, the tonnage of the US and Chinese navies could be nearing parity in the Pacific, without any redistribution of US vessels. However, this does not imply that the Chinese navy will reach parity in terms of quality and overall capability. By 2030, the US Navy will still consist of on average larger and more capable ships, especially large aircraft carriers and highly capable nuclear attack-submarines.

Future naval power balance is of course not a mere numbers game. Potentially disruptive technologies are constantly being conceptualised, developed and tested. Unmanned surface and underwater vehicles and aircraft, lasers, railguns, nuclear powered torpedoes, ballistic and hypersonic missiles anti-ship missiles, new generations of sonars and radars all have the potential to alter the naval power balance in favour of one nation or the other. It could also give comparative advantages in different areas, forcing navies to adapt their strategic thinking.

Estimating future quantities of army equipment is more difficult than for navies, as quantities are larger. Furthermore, production plans are harder to track and can be changed more quickly. However, continued modernisation and increased quality seems to be a more certain trend. China seems likely to continue replacing old equipment, while maintaining large quantities. The PLA could very well complete its modernisation, replacing its legacy systems, by 2030. By that time, however, the US plans to replace its current Bradleys with a new generation of infantry fighting vehicle and will likely have completed upgrading its Abrams tanks to a new standard.[52] The E4 would similarly have begun to replace infantry fighting vehicles as well as some main battle tanks with new generations.[53] Russia will likely continue to focus on upgrading equipment, maintaining large quantities while slowly introducing the next generation of army equipment based around the Armata platform. All major world powers are in the process of introducing new subsystems, such as active protection systems while also exploring new types of systems altogether, such as unmanned and autonomous ground vehicles.

Future quantities of air force equipment are also quite difficult to estimate, for much the same reason as army equipment. Trends from previous decades could provide some clues. However, should defence spending actually increase as advertised, the downward trend of recent decades might be reversed or at least slowed down. Modernisation efforts and qualitative improvements are easier to

[52] For US Abrams upgrade, see Mizokami, Kyle (2019) "Here's How the U.S. Army Is Upgrading the Abrams Tank for Its Fifth Decade in Service", *Japolnik*. 4 Mar 2019. (Accessed 24 November 2020). For US Bradley replacement, see Mehta, Aron (2020) "US Army releases draft RFP for Bradley vehicle replacement", *DefenseNews*, 17 Jul 2020. (Accessed 24 November 2020).

[53] *Defenseworld* (2020) "Germany, France to Launch Architectural Study on Future European Tank Project", 24 February 2020. (Accessed 24 November 2020).

foresee, at least in the short run. The US will continue to acquire and introduce F-35 throughout the 2020s, gradually replacing F-16s. In an attempt to keep up, China and Russia will likely continue to develop and improve their nascent fifth generation combat aircraft capabilities, currently consisting of the J-20 and Su-57 respectively. However, it remains to be seen to what degree those efforts will be successful. The European picture will likely continue to vary somewhat, with some countries having procured F-35 while others are aiming to replace fourth generation fighters with sixth generation. European countries are currently developing two competing sixth generation projects, one UK-Swedish-Italian and one Franco-German-Spanish initiative.[54] Meanwhile, the US has decided on two sixth generation projects, one for the air force and one for the navy.[55] Rumours are also circulating about possible Chinese and Russian sixth generation aircraft.[56] However, it is unclear at what stage of development these are in as both countries are still in the phase of developing fifth generation capabilities. Unmanned aerial vehicles (UAVs) have been a part of air power for some time, but future developments may also include unmanned "loyal-wingmen", UAVs which can accompany and complement manned combat aircraft.

Concluding Remarks on Future Trends

Well aware of the numerous uncertainties when trying to predict future trends, it is nevertheless the assessment of this study that the next decade will likely see a continued shift of economic power, away from the US towards China. Save for an economic collapse or otherwise disruptive crisis, current trends indicate that China could overtake the US to become the world's largest economy in nominal terms around 2030, while in terms of purchasing power this shift occurred in 2016. Meanwhile, the US will most likely remain the largest military spender by 2030 and maintain its overall military advantage, even though the capability gap towards near peer competitors may continue to narrow. China is likely to build a navy which outnumbers its US counterpart by 2030. The average US vessel will still be larger and more capable compared to other great powers, but China will narrow the gap in terms of tonnage. The US advantage in the air and below the surface,

[54] For the UK-Swedish-Italian project, see Defenseworld (2020) "Sweden & Italy to Collaborate in Developing Future Combat Air Capabilities", 22 July 2020. (Accessed 24 November 2020). For the Franco-German-Spanish project, see *Reuters* (2020) "France, Germany sign contract to develop fighter jet prototype", 20 February 2020. (Accessed 24 November 2020).

[55] For US Air Force project, see Pickrell, Ryan (2020) "The US Air Force secretly built and flew a prototype of its mysterious next-generation fight jet", *Businessinsider*, 15 September 2020. (Accessed 24 November 2020). For US Navy project, see Mizokami, Kyle (2020) "The Navy Is Finally Creating America's Next Fighter Jet", Popularmechanics. 20 August 2020. (Accessed 24 November 2020).

[56] For possible Chinese future aircraft projects, see Zhen, Liu (2020) "China trails as US sixth-generation jet project gets airborne", *South China Morning Post*, 22 September 2020. (Accessed 24 November 2020). For possible Russian future aircraft projects, see Suciu, Peter (2020) "Is Russia Developing a Sixth-Generation Stealth Fighter Jet?", *Nationalinterest*, 3 September 2020. (Accessed 24 November 2020).

however, will likely remain or even expand. Both the US and Chinese army equipment will likely be upgraded and to some extent replaced during the coming decade, while China will likely continue playing catch-up when it comes to the next generation of combat aircraft.

The E4 have sought to increase military spending in recent years. While France and the UK have stated that these efforts will continue,[57] long-term European defence funding will depend on the political priorities given to defence in the aftermath of the coronavirus pandemic. It is, however, likely that E4 navies will expand somewhat until 2030, reversing the stagnant trend of past decade. Even with modest economic growth rates, the size of the Eurozone economy makes it highly likely that it will continue to widen the economic gap towards Russia. However, this does not imply that Russia will become comparatively weak, especially not in terms of military power. Russia will likely continue to develop its armed forces, even if the resources at its disposal becomes more limited. The Russian navy is likely to expand, while army and air force equipment are likely to continue being upgraded. Both the E4 and Russia are simultaneously in the process of developing new types of army equipment and new generations of combat aircraft.

Finally, the changing global power balance observed in this study does not imply a definite power shift between the US and China. US power rests not only in its GDP and military expenditure, but in its network of alliances, its soft power and innovative technological edge. Nonetheless, the continued increase of China's economic and military power will have major implications, not only for the relations between the world's two largest economies or their respective relationships to Europe and Russia, but for the global community as a whole.

[57] For France, see Mackenzie, Christina (2020) "Despite pressure from lawmakers and pandemic, French defense budget to remain unchanged", *Defensenews*, 5 October 2020. (Accessed 24 November 2020). For UK, see *BBC* (2020) "Defence funding boost 'extends British influence', 20 November 2020. (Accessed 24 November 2020).

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Appendix A: Military Expenditure

Table A.1: Top 25 Military Spenders in the World, 2019. Source: SIPRI (2020a).

Country	Billion USD (current prices)	Share of the world (%)	Share of GDP (%)	Average change 2010-19 (%)	Average change 2017-19 (%)
US	731.8	39.2	3.4	-1.8	+4.2
China	261.1	14.0	1.9	+7.1	+5.7
India	71.1	3.8	2.4	+3.6	+4.7
Russia	65.1	3.5	3.9	+3.5	+0.5
Saudi Arabia	61.9	3.3	8.0	N/A	-6.4
France	50.1	2.7	1.9	+0.4	-0.4
Germany	49.3	2.6	1.3	+1.7	+6.3
UK	48.7	2.6	1.7	-1.8	+0.5
Japan	47.6	2.5	0.9	+0.2	+0.0
South Korea	43.9	2.3	2.7	+3.5	+6.3
Brazil	26.9	1.4	1.5	+0.7	+3.1
Italy	26.8	1.4	1.4	-1.1	-0.2
Australia	25.9	1.4	1.9	+2.4	-0.2
Canada	22.2	1.2	1.3	+3.0	-1.2
Israel	20.5	1.1	5.3	+3.0	+0.9
Turkey	20.4	1.1	2.7	+7.4	+16.4
Spain	17.2	0.9	1.2	-0.6	+2.4
Iran	12.6	0.7	2.3	-3.9	-19.1
Netherlands	12.1	0.6	1.3	+1.2	+10.0
Poland	11.9	0.6	2.0	+4.9	+7.9
Singapore	11.2	0.6	3.2	+2.2	+3.6
Taiwan	10.4	0.6	1.7	+0.3	-0.5
Algeria	10.3	0.6	6.0	+8.3	+1.9
Pakistan	10.3	0.5	4.0	+6.1	+6.4
Colombia	10.1	0.5	3.2	+2.0	+2.4
Top 25	**1679.4**	**89.9**	**2.3***	**+0.6**	**+3.2**
World Total	**1868.1**	**100.0**	**1.8***	**+0.5**	**+3.2**

* Average

Military expenditure in 2019 is denoted in current prices while average changes in military spending are given in 2018 constant prices. Note that SIPRI's definition of military expenditure not only includes direct expenditure on armed forces, but also indirect military spending on e.g. paramilitary forces, military pensions and R&D. Meanwhile, expenditure related to civil defence is excluded.[58] SIPRI's reporting method for Saudi Arabia changed in 2016. Data before 2016 included non-paramilitary forces and likely overestimated Saudi military expenditure prior to that year. The change between 2010 and 2019 for Saudi Arabia has therefore been marked with N/A. Furthermore, the UAE is excluded, as estimates have not been provided by the SIPRI since 2014.[59]

[58] SIPRI (2020) *SIPRI Military Expenditure Database: Sources and Methods*. (Accessed 29 Oct. 2020).
[59] SIPRI (2020a) *SIPRI Military Expenditure Database*.

Appendix B: Macroeconomic Trends

Table B.1: Top 25 Economies in the World, 2019. Source: World Bank (2020a, 2020b).

Country	Billion USD (current prices)	Share of the world 2019 (%)	Share of the world 2000 (%)	Average change 2010-19 (%)	Average change 2017-19 (%)
US	21,428	24.4	30.5	+2.3	+2.5
China	14,343	16.3	3.6	+7.7	+6.6
Japan	5,082	5.8	14.5	+1.3	+1.1
Germany	3,846	4.4	5.8	+2.0	+1.5
India	2,875	3.3	1.4	+7.0	+5.8
UK	2,827	3.2	4.9	+1.9	+1.5
France	2,716	3.1	4.1	+1.4	+1.8
Italy	2,001	2.3	3.4	+0.3	+0.9
Brazil	1,840	2.1	1.9	+1.4	+1.2
Canada	1,736	2.0	2.2	+2.2	+2.3
Russia	1,700	1.9	0.8	+2.0	+1.9
South Korea	1,642	1.9	1.7	+3.3	+2.6
Spain	1,394	1.6	1.8	+1.1	+2.4
Australia	1,393	1.6	1.2	+2.6	+2.3
Mexico	1,258	1.4	2.1	+2.7	+1.4
Indonesia	1,119	1.3	0.5	+5.4	+5.1
Netherlands	909	1.0	1.2	+1.5	+2.4
Saudi Arabia	793	0.9	0.6	+3.5	+0.7
Turkey	754	0.9	0.8	+5.9	+3.7
Switzerland	703	0.8	0.8	+1.9	+1.8
Poland	592	0.7	0.5	+3.6	+4.7
Thailand	544	0.6	0.4	+3.6	+3.6
Sweden	531	0.6	0.8	+2.5	+1.9
Belgium	530	0.6	0.7	+1.6	+1.6
Argentina	450	0.5	0.8	+1.4	-0.7
Top 25	**69,667**	**83.2**	**87.0**	**+2.8***	**+2.4***
World Total	**87,752**	**100.0**	**100.0**	**+3.8**	**+3.5**

* Average

GDP for 2019 indicated in current prices while changes are given in 2010 constant prices USD.[60] Note that the World Bank excludes Taiwan and that data are missing for Iran, which means that these are not included among the top 25 economies.

[60] GDP in constant prices 2010 USD are collected from World Bank (2020a) *GDP Constant 2010 US$*, while GDP in current prices are collected from World Bank (2020b) *GDP Current US$*.

Appendix C: Equipment Quantities

The data on equipment quantities presented in the figures and tables of Appendix C has been compiled from the 2000, 2005, 2010, 2015 and 2020 volumes of IISS *The Military Balance*. It is important to note that IISS presents quantities of equipment "in active service", which is not the same as equipment readily available for operational use. The data from IISS also feature some inconsistencies with regards to the nomenclature and clustering of equipment into types, both over time and between countries. When IISS indicates that a certain type of equipment is in active service, but does not specify a quantity, the quantity is marked as "some". IISS also classifies some equipment as being kept in "storage" or "reserve". This includes equipment which could be everything from near operational to only used for spare parts, but such variations in status is not specified.

Surface combatants in this study include aircraft carriers, amphibious assault ships, cruisers, destroyers, frigates and corvettes. The main rule of thumb has been to include ships capable of carrying combat aircraft, missiles or both. However, missile boats and fast attack craft are excluded due to their limited size and capabilities.[61] Furthermore, the vast numbers of such vessels possessed by China and Russia would have skewed comparisons of ship quantities. Submarines include nuclear armed strategic submarines (SSBN), torpedo and missile armed tactical submarines with nuclear propulsion (SSN) and tactical submarines with conventional propulsion (SSK). Mini-submarines and special purpose submarines are excluded. While IISS data generally do not account for availability, Russian naval vessels kept in reserve or undergoing long-term overhaul are not included. This study has not adjusted for this minor inconsistency, but it is worth noting that this may lead to a slight underestimation of ships in active service for Russia. The exemption also applies to three German submarines in 2020, undergoing long-term overhaul.

Also note that there is no internationally accepted classification of surface combatants, i.e. what actually distinguishes a small destroyer from a large frigate. IISS sometimes attempts to adjust for changes in roles and capabilities. However, this study has kept the national classifications. The consequences are generally limited, but the use of national classifications means that the French European multi-mission frigates (FREMM) of the Aquitaine class are categorised as destroyers while the Italian FREMM Bergamini class are categorised as frigates.

Main battle tanks are heavily armoured vehicles, armed with a powerful main gun for direct fire. There is no widely accepted standard for what constitutes a main battle tank and these can vary considerably in size. However, wheeled tanks are usually not included in the definition and have also been excluded in this study.

[61] The distinction between a coastal corvette and a missile attack craft is often not clearly defined. However, this study classifies coastal corvettes displacing less than 500 tonnes as missile attack craft, thereby excluding them from the overall tally.

Infantry fighting vehicles (IFVs) provide infantry with armoured transportation and fire support. Armoured personnel carriers (APCs) perform similar tasks but are generally, though not always, more lightly armed. Both IFVs and APCs can be either wheeled or tracked. Artillery and multiple rocket launch systems (MLRSs) provide ground forces with indirect fire.

Combat aircraft perform both ground attack and air superiority missions, generally armed with missiles and automatic cannons. In this study combat aircraft includes multirole aircraft as well as more purpose-built fighters and attack aircraft. Meanwhile purpose-built large bombers have been given a separate category. Transport aircraft provide troops the ability to deploy rapidly and over large distances. These vary greatly in size, but all except light personal transport aircraft are included.

USA

US Navy Surface Combatants and Submarines

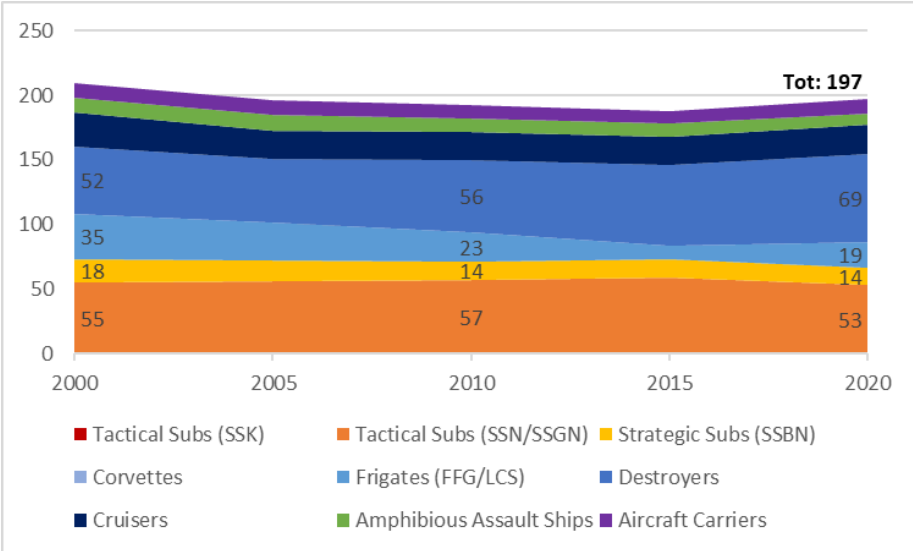

Figure C.1: US Navy surface combatants and submarines, 2000-2020. Source: IISS

Classes of: Aircraft carriers: Gerald R. Ford, Nimitz, Enterprise, John F. Kennedy, Kitty Hawk. Amphibious assault ships: America, Wasp, Tarawa. Cruisers: Ticonderoga. Destroyers: Zumwalt, Arleigh Bourke Flight I/II/IIA, Spruance. Frigates: Oliver Hazard Perry. Littoral combat ships: Freedom, Independence. Strategic nuclear submarines: Ohio. Tactical nuclear submarines: Virginia Flight I/II/III, Seawolf, Ohio (Mod), Los Angeles (Imp), Los Angeles, Sturgeon.

Table C.1: US Navy surface combatants and submarines, 2000-2020. Source: IISS.

Type/Year	**2000**	**2005**	**2010**	**2015**	**2020**
Aircraft Carriers	12	11	11	10	11
Amphibious Assault Ships	11	12	10	10	9
Cruisers	27	22	22	22	22
Destroyers	52	49	56	62	69
Frigates & LCSs	35	30	23	11	19
Strategic Nuclear Submarines	18	16	14	14	14
Tactical Nuclear Submarines	55	56	57	59	53
Total	**210**	**196**	**193**	**188**	**197**

US Army Equipment

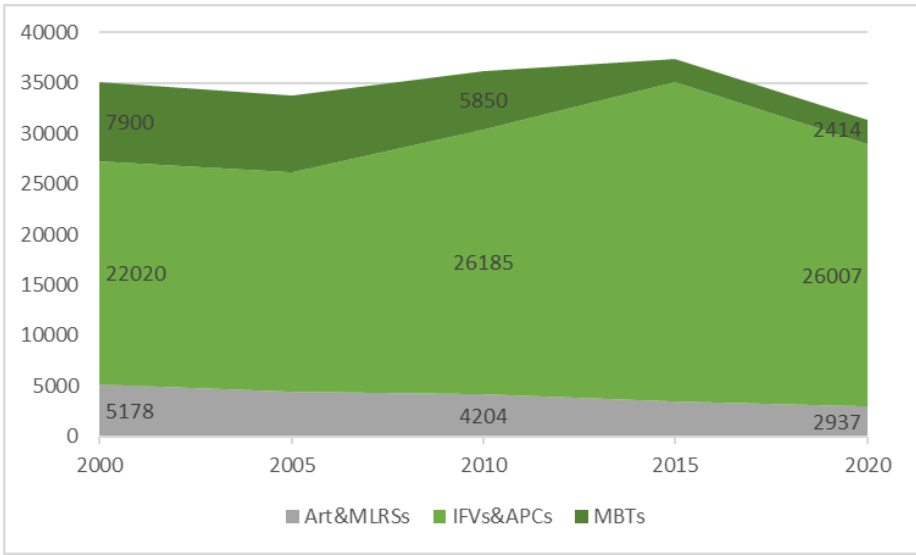

Figure C.2: US Army equipment, 2000-2020. Source: IISS

Types of: Main battle tanks (MTBs): M1A2/C Abrams, M1A1 Abrams, M1 Abrams. Infantry fighting vehicles (IFVs): M7A3 Bradley, M2/A Bradley. Reconnaissance vehicles: M3A2/A3 Bradley, M7A3 Bradley, M1127 Stryker, Tpz Fuchs. Armoured personnel carriers (APCs): MRAP, M-ATV, LAV-25, JLTV, M1117 Guardian, M1200 Armoured Knight, Stryker, M113. Artillery: M109A1/A2/A6/A7, M777, M198, M119, M102. Multiple launch rocket systems (MLRSs): M142 HIMARS, M270.

Table C.2: US Army equipment, 2000-2020. Source: IISS.

Type/Year	**2000**	**2005**	**2010**	**2015**	**2020**
Main Battle Tanks	7900	7620	5850	2338	2414
Infantry Fighting Vehicles	6710	6719	6452	4559	2834
Reconnaissance Vehicles	110	96	96	1435	1745
Armoured Personnel Carriers	15200	14900	19637	25674	21428
Artillery	4103	3634	3374	2211	2337
Multiple Launch Rocket Systems	1075	830	830	1205	600
MBTs (Reserve)	-	-	-	3500	3500
IFVs (Reserve)	-	-	-	2000	2000
Rec (Reserve)	-	-	-	-	800
APCs (Reserve)	-	-	-	8000	8000
Artillery (Reserve)	-	-	-	500	500

US Air Force, Navy and Marine Corp Aircraft

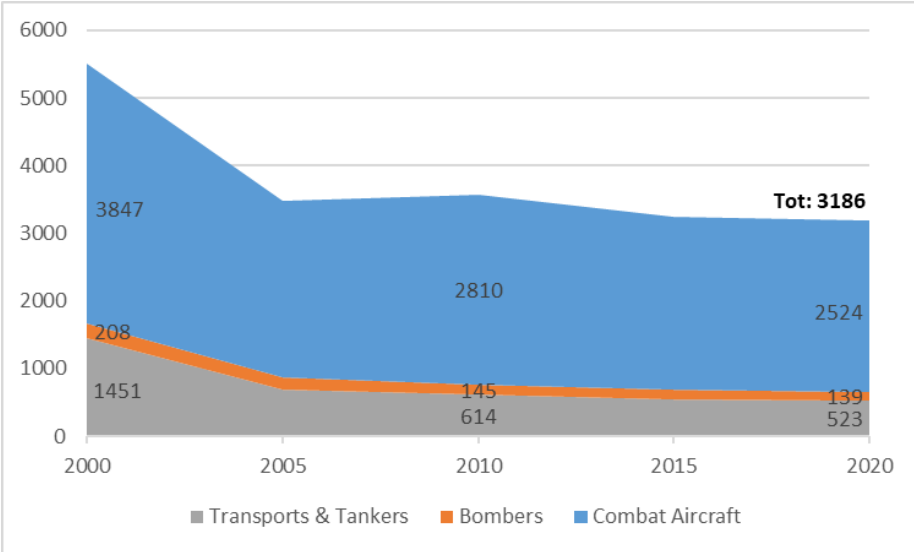

Figure C.3: US Air Force, Navy and Marine Corp aircraft, 2000-2020. Source: IISS

Types of: Combat aircraft: F-35B/C, F-35A, F-22, F-18E/F, F-18A/B/C/D, F-111, F-16A/B/C/D, F-15E, F-15A/B/C/D, F-14A/B/D, OA-10A/A-10C, AV/TAV-8, A-10A. Bombers: B-2, B-1B, B-52. Transports: C-5, C-17A, C-130, C-141, C-135. Tankers: KC-46A, KC-10A, KC-135.

Table C.3: US Air Force, Navy and Marine Corp aircraft, 2000-2020. Source: IISS.

Type/Year	**2000**	**2005**	**2010**	**2015**	**2020**
Combat Aircraft	3847	2611	2810	2557	2524
Bombers	208	174	145	137	139
Transport	846	383	373	327	286
Tankers	605	314	241	226	237
Total	**5506**	**3482**	**3569**	**3247**	**3186**

China

PLA Navy Surface Combatants and Submarines

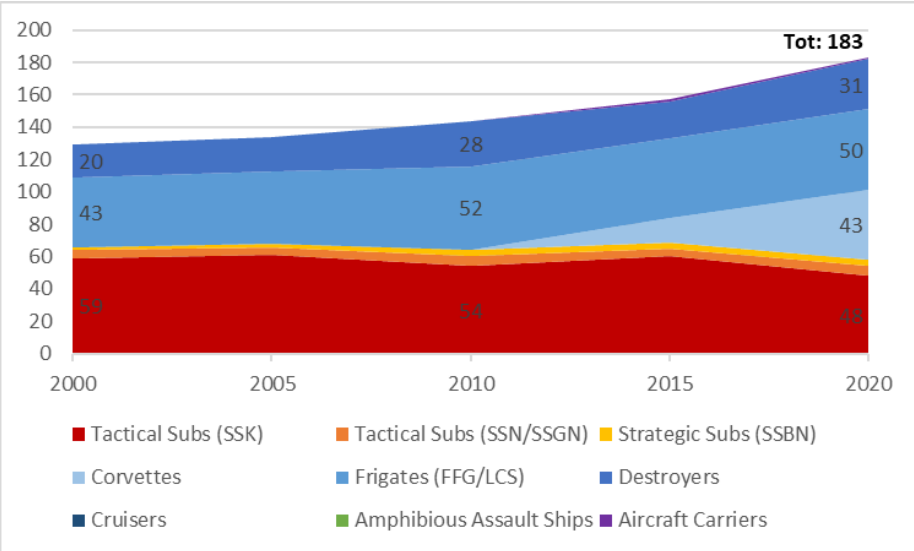

Figure C.4: PLA Navy surface combatants and submarines, 2000-2020. Source: IISS

Classes of: Aircraft carriers: Type 001. Destroyers: Type 055, Type 052D, Type 052C, Type 052B, Type 051C, Type 051B, Sovremenny, Type 052, Type 051/D/G. Frigates: Type 054A, Type 054, Type 053H. Corvettes: Type 056/A. Strategic submarines: Type 094, Type 092, Golf. Tactical nuclear submarines: Type 093B, Type 093A, Type 091. Tactical conventional submarines: Type 039A, Type 039, Kilo 636.3, Kilo 877, Type 035, Type 033.

Table C.4: PLA Navy surface combatants and submarines, 2000-2020. Source: IISS.

Type/Year	**2000**	**2005**	**2010**	**2015**	**2020**
Aircraft Carriers	-	-	-	1	1
Destroyers	20	21	28	23	31
Frigates	43	45	52	49	50
Corvettes	-	-	-	15	43
Strategic Submarines	2	2	4	4	4
Tactical Nuclear Submarines	5	5	6	5	6
Tactical Conventional Subs	59	61	54	60	48
Total	**129**	**134**	**144**	**157**	**183**

PLA Army Equipment

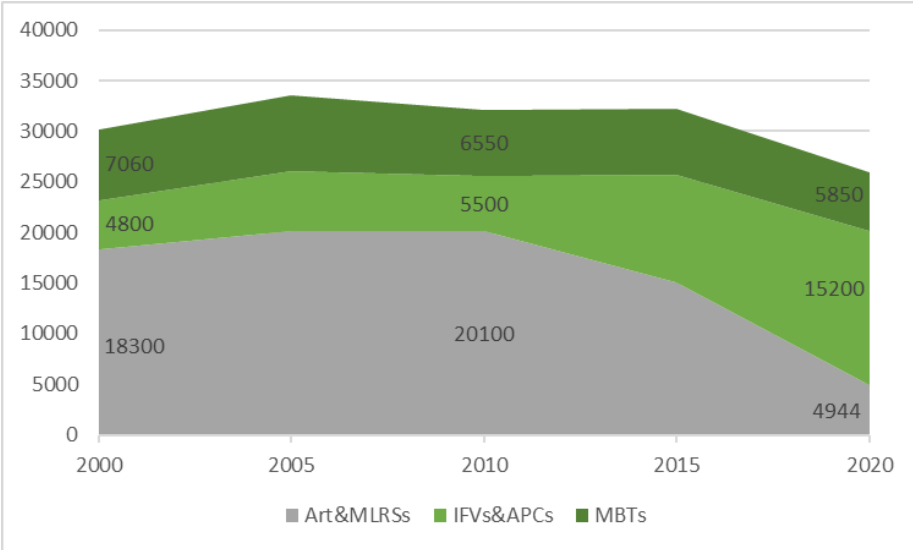

Figure C.5: PLA Army equipment, 2000-2020. Source: IISS

Types of: Main battle tanks (MBTs): ZTZ-99/A, ZTZ-96/A, ZTQ-15, ZTZ-88, ZTZ-79, ZTZ-69, ZTZ-59. Infantry fighting vehicles (IFVs): ZTL-11, ZTS-63A, ZTD-05, ZBD-04/A, ZDB-86/A, BTR-50. Armoured personnel carriers (APCs): ZSL-10, ZBL-08, ZSL-93, ZSL-92/A/B, ZSD-89, ZSD-63. Artillery: PLZ-07, PLZ-05, PCL-18, PLC-09, PLL-09, PLZ-89, PLZ-83, PLZ-45, PL-96, PL-54/-59/-66, Type-60, Type-56. Multiple launch rocket systems (MLRSs): PHZ-10/-11, PHL-19, PHL-11, PHL-03, PHZ-89, PHZ-81/-90, PH-63.

Table C.5: PLA Army equipment, 2000-2020. Source: IISS.

Type/Year	2000	2005	2010	2015	2020
Main Battle Tanks	7060	7580	6550	6540	5850
Infantry Fighting Vehicles	Some	1200	1100	2120	4300
Armoured Personnel Carriers	4800	4700	4400	8570	10900
Artillery	15800	17700	17700	13178	3374
Multiple Launch Rocket Systems	2500	2400	2400	1872	1570

PLA Air Force and Navy Aircraft

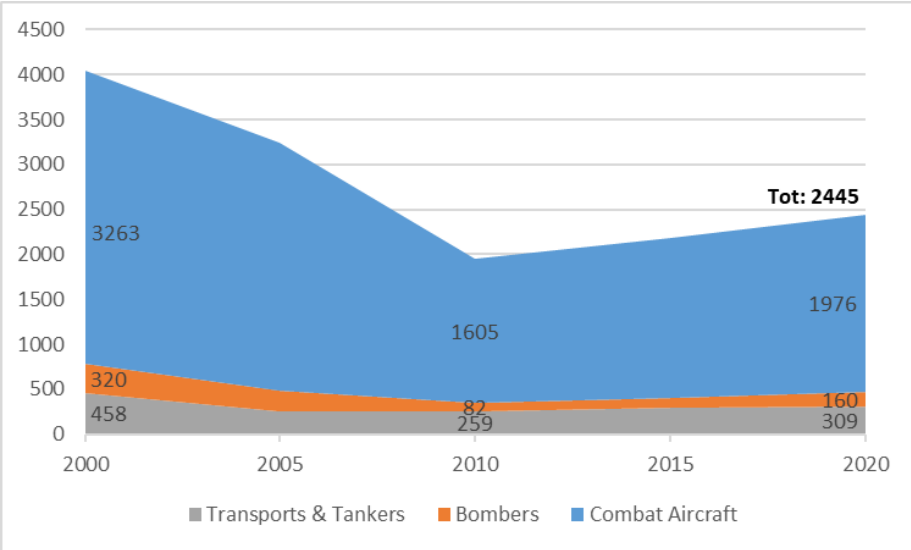

Figure C.6: PLA Air Force and Navy aircraft, 2000-2020. Source: IISS

Types of: Combat aircraft: J-20, J-16, J-15, J-10, Su-35, Su-30MKK/MK2, J-11B/BS, J-11/Su-27, JH-7/A, J-8A/B/E, J-7, Q-5, J-6. Bombers: H-6, H-5. Transports & tankers: Y-20, Il-76, Y-9, Y-8, Y-12, Y-11, Y-7, Y-5, Il-18.

Table C.6: PLA Air Force and Navy aircraft, 2000-2020. Source: IISS.

Type/Year	**2000**	**2005**	**2010**	**2015**	**2020**
Combat Aircraft	3263	2769	1605	1787	1976
Bombers	320	222	82	106	160
Transport & Tankers	458	258	259	296	309
Total	**4041**	**3249**	**1946**	**2189**	**2445**

European Four

French, German, UK and Italian Navy Surface Combatants and Submarines

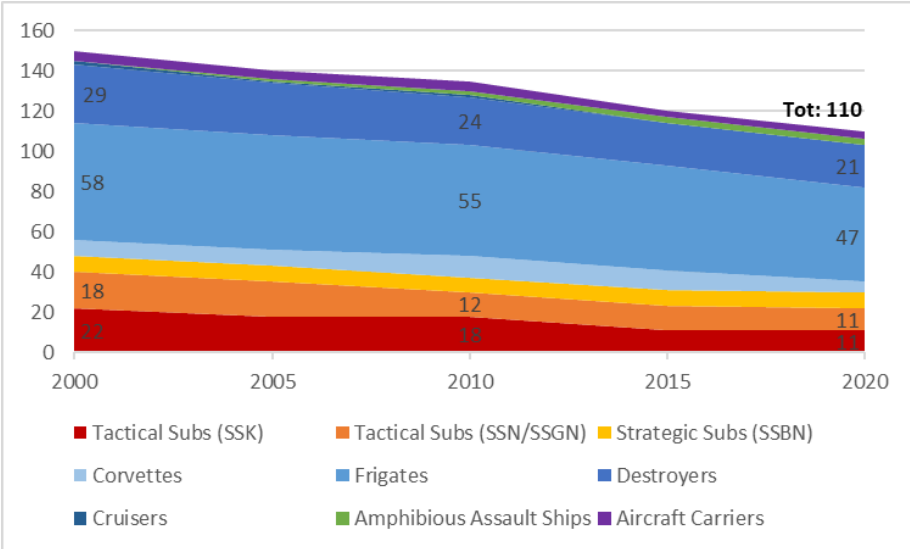

Figure C.7: E4 Navy surface combatants and submarines, 2000-2020. Source: IISS

Classes of: Aircraft carriers: Charles de Gaulle, Clémenceau, Queen Elizabeth, Invincible (mod.), Invincible, Cavour, Guiseppe Garabaldi. Amphibious assault ship: Mistral. Cruisers: Jeanne d'Arc, Vittorio Veneto. Destroyers: Aquitaine, Forbin, Cassard, Georges Leygues, Tourville, Lütjens, Type 45, Type 42, Andrea Doria, Durand de la Penne, Audace. Frigates: La Fayette, Floreal, Sachsen, Brandenburg, Bremen, Type 23, Type 22 Batch 2/3, Bergamini, Maestrale, Artiglieri, Lupo. Corvettes: Braunschweig, Minerva. Strategic nuclear submarines: Vanguard, Le Triumphant, Redoutable. Tactical nuclear submarines: Astute, Trafalgar, Swiftsure, Rubis. Tactical conventional submarines: Agosta, Type 212A, Type 206/206A, Type 205, Todaro, Pelosi, Sauro.

Table C.7: E4 Navy surface combatants and submarines, 2000-2020. Source: IISS.

Class/Year	**2000**	**2005**	**2010**	**2015**	**2020**
Aircraft Carriers	5	4	5	3	4
Amphibious Assault Ships	-	1	2	3	3
Cruisers	2	1	1	-	-
Destroyers	29	26	24	21	21
Frigates	58	57	55	52	47
Corvettes	8	8	11	10	5
Strategic Nuclear Submarines	8	8	7	8	8
Tactical Nuclear Submarines	18	17	12	12	11
Tactical Conventional Subs	22	18	18	11	11
Total	**150**	**140**	**135**	**120**	**110**

French, German, UK and Italian Army Equipment

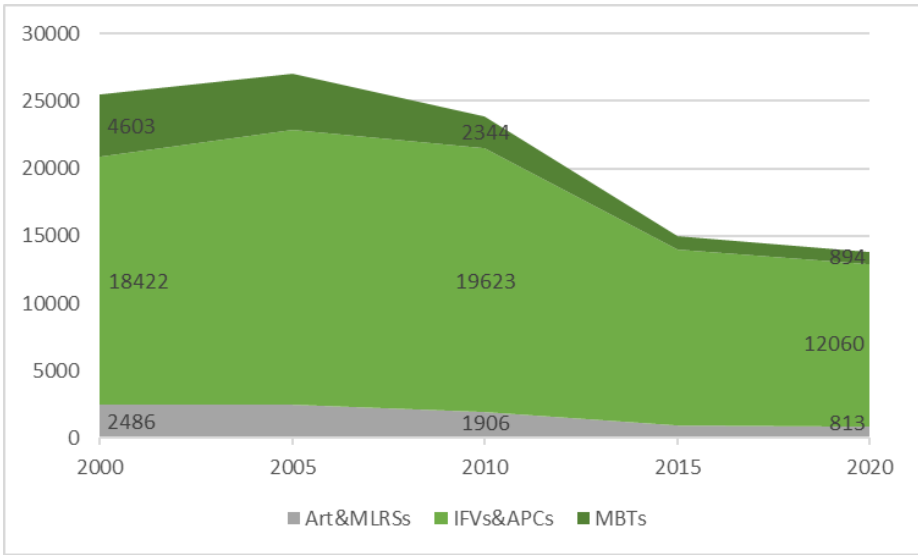

Figure D.8: E4 Army equipment, 2000-2020. Source: IISS

Types of: Main battle tanks (MTBs): Leclerc, AMX-30, Leopard 2A7/A6/A4, Leopard 1, Challenger 2, Challenger 1, Chieftain, C1 Ariete. Infantry fighting vehicles (IFVs): VBCI, AMX-10, Puma, Marder, Wiesel, Warrior, Rarden, Centauro, Dardo, Freccia. Reconnaissance vehicles: VBL, AMX-10RC, AML-60/90, Wiesel, Fennek, Tpz-1, SPz-2, Ajax, Jackal, Sabre, FV 101. Armoured personnel carriers (APCs): BvS-10, VAB, VBMR, Bv-206, M-113, Boxer, TpZ-1, Eagle, Dingo, Ares, Athena, Panther, Warthog, Stormer, Bulldog, Spartan, Ridgeback, Mastiff, Foxhound, Saxon, Saracen, VCC-1, Fiat 6614, Cougar, VBR NBC. Artillery: CAESAR, AU-F-1, TR-F-1, PzH-2000, M110, FH-70, M-101, M-56, AS-90, FV 433, M-109, M-107, M-110, L-118/-119, Mod 56. Multiple launch rocket systems (MLRSs): M270, MLRS 227, LARS.

Table D.8: E4 Army equipment, 2000-2020. Source: IISS.

Type/Year	**2000**	**2005**	**2010**	**2015**	**2020**
Main Battle Tanks	4603	4187	2344	997	894
Infantry Fighting Vehicles	3887	3853	3882	2200	2457
Reconnaissance Vehicles	2432	2807	2565	2615	2604
Armoured Personnel Carriers	12103	13750	13176	8209	6999
Artillery	2108	2118	1630	830	702
Multiple Launch Rocket Systems	378	340	276	139	111

French, German, UK and Italian Air Force and Navy Aircraft

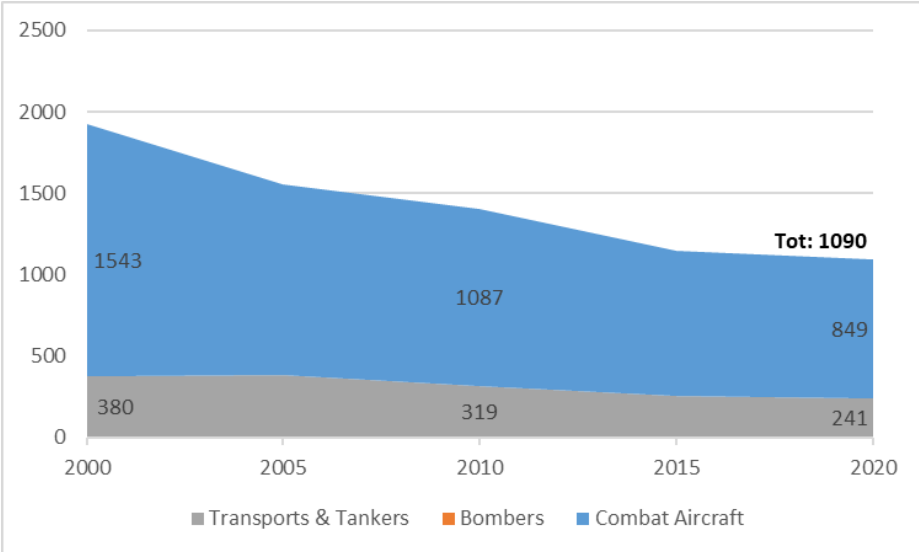

Figure C.9: E4 Air Force and Navy aircraft, 2000-2020. Source: IISS

Types of: Combat aircraft: Rafale, Mirage 2000, Mirage F-1, Super Etard, F-35, Eurofighter, Tornado, F-16, Harrier, Jaguar, Ghibli, F-4, Su-22, F-104, MiG-29, MiG-23, MiG-21. Transports: A310, A400M, C-17A, C-130, C-160, CN-235, DHC-6-300, B-707-320C, TBM-700, C-27J, A-319, G-222, MB-339. Tankers: A330, KC-135, KC-767A, KC-130J, C-135FR, C-160R, VC-10, TriStar.

Table C.9: E4 Air Force and Navy aircraft, 2000-2020. Source: IISS.

Type/Year	**2000**	**2005**	**2010**	**2015**	**2020**
Combat Aircraft	1543	1173	1087	891	849
Transports & Tankers	380	383	319	253	241
Total	**1923**	**1556**	**1406**	**1144**	**1090**

Russia

Russian Navy Surface and Submarines Combatants

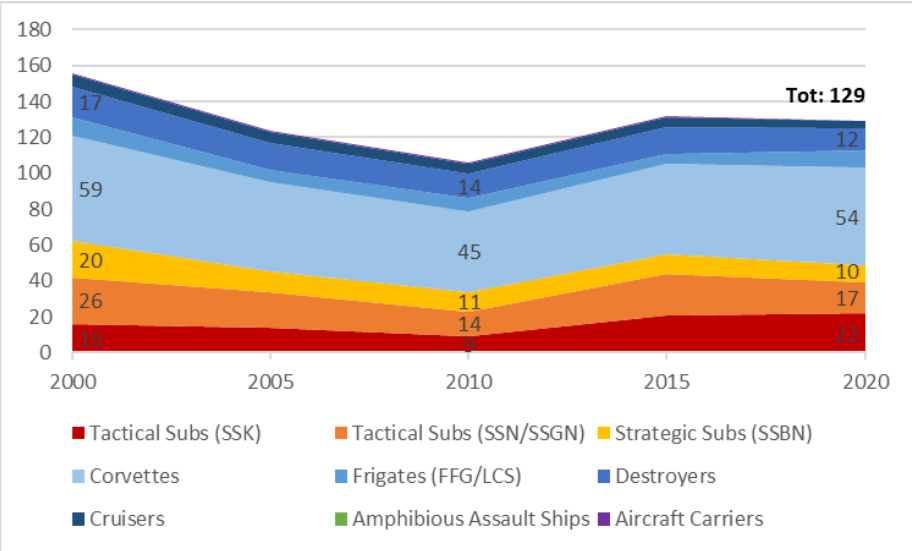

Figure C.10: Russian Navy surface combatants and submarines, 2000-2020. Source: IISS

Classes of: Aircraft carriers: Kuznetsov. Cruisers: Kirov, Slava, Kara, Kynda. Destroyers: Udaloy I/II, Sovremenny, Kashin mod., Kashin. Frigates: Gorshkov, Krivak V, Gepard, Neustrashimyy, Krivak I/II. Corvettes: Steregushchiy, Buyan/M, Parchim II, Grisha I/III/IV/V, Nanuchka III/IV. Strategic nuclear submarines: Dolgorukiy, Typhoon, Delta I/III/IV, Yankee I/II. Tactical nuclear submarines: Graney, Victory III, Sierra I/II, Akula I/II, Oscar II. Tactical conventional submarines: Lada, Kilo 636.3, Kilo 877, Tango, Foxtrot.

Table C.10: Russian Navy surface combatants and submarines, 2000-2020. Source: IISS.

Class/Year	**2000**	**2005**	**2010**	**2015**	**2020**
Aircraft Carriers	1	1	1	1	-
Cruisers	7	6	5	5	4
Destroyers	17	15	14	15	12
Frigates	10	7	7	6	10
Corvettes	59	50	45	50	54
Strategic Nuclear Submarines	20	11	11	11	10
Tactical Nuclear Submarines	26	20	14	23	17
Tactical Conventional Subs	16	14	9	21	22
Total	**156**	**124**	**106**	**132**	**129**

Russian Army Equipment

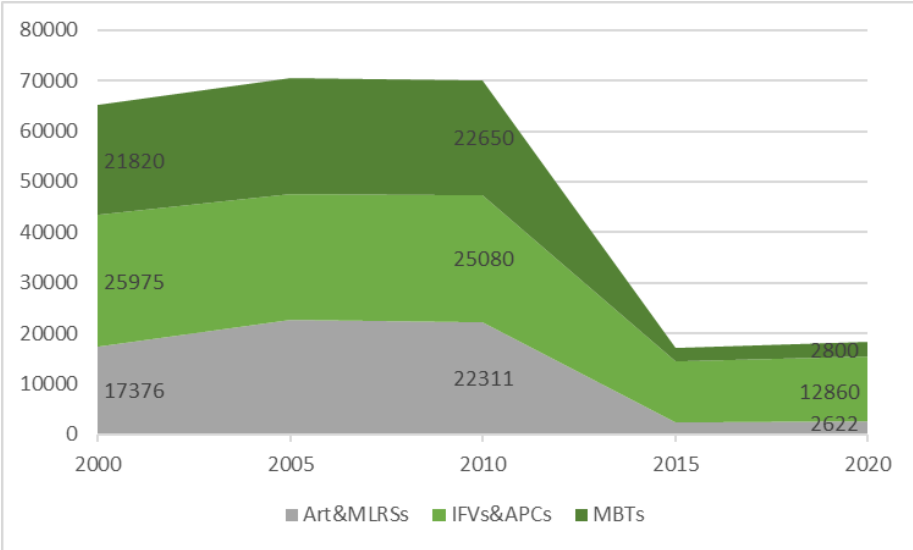

Figure C.11: Russian Army equipment, 2000-2020. Source: IISS

Types of: Main battle tanks (MBTs): T-90/A, T-80BVM, T-80BV/U, T-80/U/UD/UM, T-72B3, T-72B/BA, T-72/L/M, T-64A/B, T-62, T-55. Infantry fighting vehicles (IFVs): BMP-3, BMP-2, BMP-1, BRM-1K, BMD, BDRM-2. Armoured personnel carriers (APCs): BMO-T, MT-LB, BPM-97, BTR-D, BTR-80/70/60/50. Artillery: Msta-SM, Msta-S, Malka, Pion, Giatsint-S, Akatsiya, Gvozdika, Msta-B, Giatsint-B, D-30, D-20, D-1, BS-3, M-46, M-30, M-20. Multiple launch rocket systems (MLRSs): Tornado-S, Smerch, Uragan, BM-24, Grad, TOS-1, BM-16, BM-13.

Table C.11: Russian Army equipment, 2000-2020. Source: IISS.

Type/Year	**2000**	**2005**	**2010**	**2015**	**2020**
Main Battle Tanks	21820	22800	22650	2600	2800
Infantry Fighting Vehicles	14700	15090	15180	4700	5760
Armoured Personnel Carriers	11275	9900	9900	7225	7100
Artillery	14770	18735	18735	1650	1760
Multiple Launch Rocket Systems	2606	3926	3576	850	862
MBTs (Reserve)	8900	-	350	17500	10200
IFVs (Reserve)	-	-	-	8500	9500
APCs (Reserve)	-	-	-	6000	6000
Artillery (Reserve)	-	-	-	16695	16635
MLRSs (Reserve)	-	-	-	3220	3220

Russian Air Force and Navy Aircraft

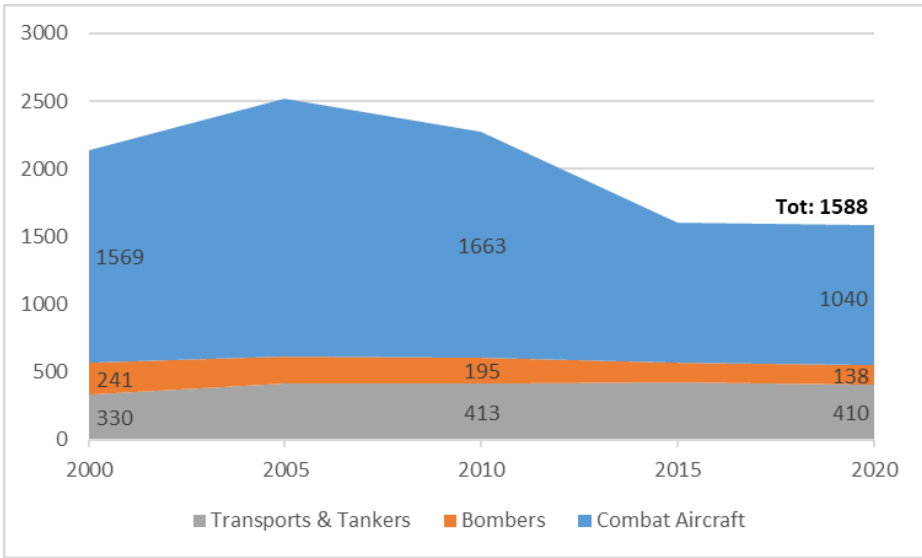

Figure C.12: Russian Air Force and Navy aircraft, 2000-2020. Source: IISS

Types of: Combat aircraft: Su-35S, Su-34, Su-30/M2/SM, Su-27/UB/SM2/SM3, MiG-29, Su-25A/SM/UB, Su-24, MiG-31, MiG-25A/E. Bombers: Tu-160, Tu-95, Tu-22. Transports & tankers: An-124, An-22, Il-76, An-12BK, An-26, An-72, An-140, L-410, Tu-134, Il-78.

Table C.12: Russian Air Force and Navy aircraft, 2000-2020. Source: IISS.

Type/Year	**2000**	**2005**	**2010**	**2015**	**2020**
Combat Aircraft	1569	1902	1663	1031	1040
Bombers	241	203	195	141	138
Transports & Tankers	330	413	413	429	410
Total	**2140**	**2518**	**2271**	**1601**	**1588**

Appendix D: Equipment Quality

The assessment of equipment quality presented in the figures of Appendix D is based on two methods. First, by sorting the quantity data collected from the IISS 2000, 2005, 2010, 2015 and 2020 volumes of *The Military Balance* into three categories: Modern, Intermediate and Legacy. The purpose of this categorisation is to broadly illustrate levels and trends of equipment modernisation among the major world powers. Secondly, the categorisation according to modernity is complemented by performance indicators for modern equipment presented in the tables of this appendix. The purpose of these indicators is to form a basis for assessing differences in quality among the modern equipment of major world powers.

The categorisation of surface combatants and submarines according to modernity is based on the decade in which the lead ship of a given class was commissioned into active service. Naval classes commissioned in the 1950s and 1960s are categorised as Legacy. Classes taken into service in the 1970s and 1980s are categorised as Intermediate. Classes where the lead ship was commissioned after 1990 are categorised as Modern. There are some exemptions to this general rule. The most notable is the surface combatants and submarines of China's PLA Navy. During the 1980s and 1990s China mainly copied or adapted older Soviet designs and only during the 2000s did China begin to produce more modern vessels. Therefore, the classification of Chinese naval vessels lags a decade behind the other major world powers. It is also worth noting that naval vessels are usually upgraded during their long life cycle. However, upgrades has not been taken into account in this classification. This may underestimate the overall modernity of the Russian, and to a lesser extent the Chinese, navies.

A conscious inconsistency is the *Sovremenny* class destroyers, which were bought by China in the early 2000s, but are classified as Intermediate for the PLA Navy as they were of older design and classified as Intermediate for the Russian navy. Another exemption is the *Ticonderoga* class cruisers of the US Navy. These cruisers were commissioned in the 1980s, but since it carries the advanced AEGIS combat system and has few international equivalents it is classified as modern. A third conscious inconsistency is the Russian aircraft carrier *Kuznetsov*, which is classified as Intermediate while its Chinese sister ship *Liaoning* is classified as modern. The reason being that the Liaoning was upgraded by China prior to being commissioned in 2012.

For main battle tanks the categorisation in this report corresponds with the generally accepted division into generations. Third generation main battle tanks are classified as Modern, while second generation tanks are classified as Intermediate, and first generation tanks classified as Legacy. Third generation tanks entered service from the 1980s, while second generation were introduced from the 1960. The first generation main battle tanks entered service after the World War II. The identification of generations has been based in a wide range of open sources. While the

exact classification presented in this appendix may not be universally accepted, the category of each tank type is presented in detail.

Combat aircraft in this study includes multirole, fighter and attack aircraft, but excludes bombers. Similarly to tanks, the categorisation corresponds with the classification into generations. Fifth and fourth generation combat aircraft are classified as Modern, while third generation are classified as Intermediate, and second generation aircraft are classified as Legacy. Fifth and fourth generation combat aircraft mainly entered service after the 1990s, while the third generation was introduced in the late 1960s to the 1980s and second generation combat aircraft were commissioned in the late 1950s and early 1970s. The identification according to generation has been done by a wide variety of open sources. While there is no generally accepted consensus on the exact classification of each aircraft type, this appendix presents the categories in detail.

While the categorisation according to modernity can offer broader insights, there may be quite significant differences in quality between the modern equipment of one country compared to another. In order to address this issue, the categorisation presented in the figures below has been complemented by tables containing a number of relevant performance indicators for selected modern surface combatants, main battle tanks and combat aircraft for the major world powers.

Surface combatant performance is assessed by the indicators number of missiles, maximum range (indicated in km) and top speed (indicated in Mach)[62] of surface-to-air missiles (SAMs) and anti-ship missiles (ASMs) respectively. The number of missiles gives a broad sense of the lethality and endurance of a given ship. Note that short-range point-defence missiles are not included in this tally. Maximum missile range is a highly theoretical measure. A missile which can fly 200 km but can only hit targets at 100 km will have a shorter effective range than a missile that can both fly and hit targets at 150 km. However, exact efficiency is difficult to obtain and even harder to verify using open sources. So while keeping this caveat in mind maximum range should provide some understanding of relative performance. Top speed, denoted here in terms of Mach, is relevant as higher speed makes avoiding or intercepting an incoming missile more difficult. However, there are several other factors at play for missile performance than just range and speed, such as size of warhead, manoeuvrability and available countermeasures, which are not included in this study. To estimate ASW capabilities, the number of helicopters and number of torpedo tubes are also indicated. Finally the number of ships in active service by class in 2000 and 2020 is presented, in order to give a picture of the trends and prevalence of the assessed capabilities. Several important quality

[62] Mach is a measure indicating the speed of sound, sonic speed is defined as 1 Mach = 1225 km/h. Speeds under 1 Mach are defined as subsonic and speeds over 1 Mach are defined as supersonic. Note that the speed of sound, and therefore 1 Mach, varies depending on air temperature and flight altitude.

parameters for surface combatants are not included in this report, such as the performance of radars, sonars and communications. The precision of weaponry is also excluded. The main reason for these delimitations is the lack of open source data. However, the vessel speed, range or endurance are also not included and here data are available. While top speeds are fairly similar for large surface combatants, around 30 knots, range and endurance varies. However, since these factors often vary with ship size they were not prioritised in this edition of the report series.

Main battle tank performance is assessed through the indicators firepower, protection and mobility. Firepower is operationalised as the penetration depth of the best available kinetic penetrator or armour-piercing fin-stabilised discarding sabot (APFSDS) round from a distance of 2,000 metres, measured in millimetres of rolled-homogenous-armour equivalents (RHAe).[63] Similarly, protection is measured by maximum armour depth against APFSDS at the front of the turret, usually the strongest protected section of a tank, also measured in millimetres of RHAe. Mobility is measured by engine horsepower (HP) through the weight of the tank, in tonnes. Based on these indicators, modern third generation classification is then nuanced by adding a plus or minus.[64] The quantity of tanks in active service in 2000 and 2020 is also presented, in order to give a picture of the trends and prevalence of the assessed capabilities. There are several quality parameters which are not included in this report, such as the precision of the main gun, quality of sensors, communications and tank maintainability. The main reason for this delimitation is the lack of open source data. However, if made available these metrics could be included in future editions of this report.

Combat aircraft performance is assessed through the number of hard points, i.e. stations for missiles, bombs or additional fuel tanks, carried. Although the performance of each individual missile is not indicated, the number of hard points does give a broad idea of the lethality of a certain aircraft. Combat range (indicated in km) and maximum speed (indicated in kmn/h) are also presented as quality indicators as they give some broad sense of the endurance and manoeuvrability of an aircraft. The generation of the aircraft, fifth or fourth, is also presented as a proxy performance indicator. Fifth generation combat aircraft combine stealth, i.e. minimised radar cross-section and radar absorbent materials, with high manoeuvrability and advanced avionics. Meanwhile, late fourth generation combat aircraft lack minimised radar cross-section but often share other stealth features with fifth generation, such as radar absorbent materials and reduced infra-red signature. As with ships and tanks, the number of combat aircraft in active service is also presented, in order to give a picture of the trends and prevalence of the assessed capabilities. Important performance features, such as data on radar-cross section, performance

[63] Note that this is a simplification as APFSDS-projectiles are often designed to defeat specific types of armour and that the generalised RHAe-values should therefore be interpreted as rough approximations.
[64] The original sources of tank performance data are the US Training and Doctrine Command (2014) *Worldwide Equipment Guide 2014* and *Steelbeast.com.*

of radar, IR-sensors, manoeuvrability and performance of weaponry are not included in this report. The main reason for this is the lack of open data as well as a proper methodological tools to account for these variables. However, given that such data and tools can be provided, future editions of this report series may very well include these metrics.

Data on performance indicators have been collected from a wide range of open sources, such as government departments and agencies, international institutes or online news outlets with a military focus. This data are referred to collectively as "FOI" in the tables below, see Section 2.1 for details. Note that open source data should be treated with degree of caution and viewed as publicly available estimates rather than absolute truths.

USA

US Navy Surface Combatants

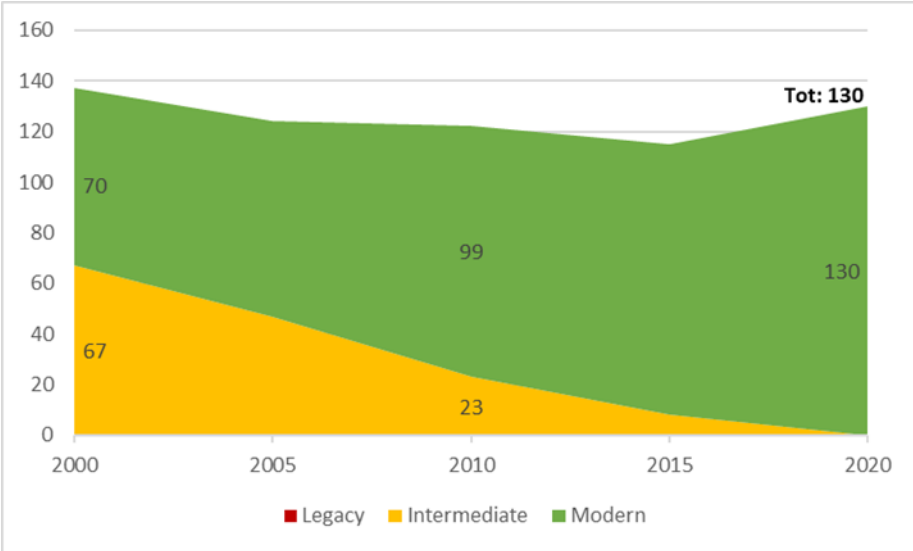

Figure D.1: US Navy surface combatants by modernity, 2000-2020. Source: IISS

Modern include classes of aircraft carriers; Gerald R. Ford, Nimitz, Enterprise, amphibious assault ships; America, Wasp, cruisers; Ticonderoga, destroyers; Zumwalt, Arleigh Bourke Flight IIA, Arleigh Bourke Flight I/II, littoral combat ships; Freedom and Independence. Intermediate includes aircraft carriers; John F. Kennedy, Kitty Hawk, amphibious assault ships; Tarawa, destroyers; Spruance, frigates; Oliver Hazard Perry. Legacy includes; none.

Table D.1: US Navy modern surface combatant performance, 2020. Source: IISS, FOI.

Class	No. Mis-siles	SAM Range/ Speed	ASM Range/ Speed	ASW TT/ Hel.	Quant. 2000	Quant. 2020
Ticonderoga	130	240/3.5	240/3.5	6/2	22	22
Zumwalt	80	240/3.5	240/3.5	-/1	0	2
Arleigh Bourke IIA	96	240/3.5	240/3.5	6/2	0	39
Arleigh Bourke II	104	240/3.5	240/3.5	6/1	7	7
Arleigh Bourke I	104	240/3.5	240/3.5	6/-	21	21
Freedom	-	-/-	-/-	-/2	0	9
Independence	-	-/-	-/-	-/1	0	10
Total (Modern)	**9,676**	**N/A**	**N/A**	**N/A**	**70**	**130**
Total (All)	**9,676**	**N/A**	**N/A**	**N/A**	**137**	**130**

All US cruisers and destroyers are capable of carrying the SM-6 ERAM dual-use surface-to-air missile (SAM) and anti-ship missile (ASM).

US Army Main Battle Tanks

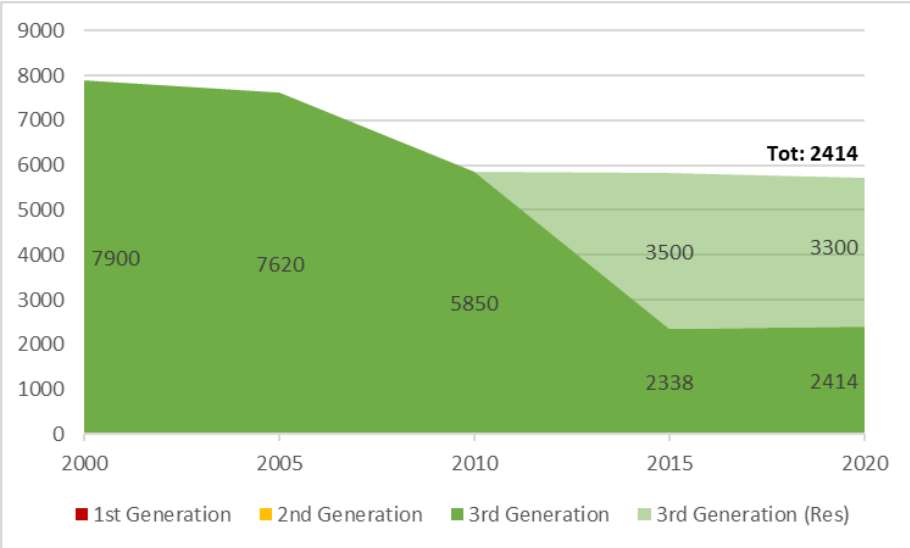

Figure D.2: US Army main battle tanks by generation, 2000-2020. Source: IISS

3rd Generation include types; M1A2C Abrams, M1A2 Abrams, M1A1 Abrams, M1 Abrams. 2nd Generation includes; none. 1st Generation includes; none. 3rd Generation in reserve includes; M1A2 Abrams, M1A1 Abrams.

Table D.2: US Army modern main battle tank performance, 2020. Source: IISS, FOI.

Type	Gen	Firepower (mm RHAe)	Armour (mm RHAe)	Mobility (HP/ tonne)	Quantity 2000	Quantity 2020
M1A2C Abrams	+3	-	-	-	0	34
M1A2 Abrams	+3	840	950	23.1	some	1605
M1A1 Abrams	3	750	600	25.9	some	775
M1 Abrams	-3	-	-	-	7900	0
M1A1/A2 (Res)	3	-	-	-	0	3300
Total (Active)	**N/A**	**N/A**	**N/A**	**N/A**	**7900**	**2414**

US Air Force, Navy and Marine Corp Combat Aircraft

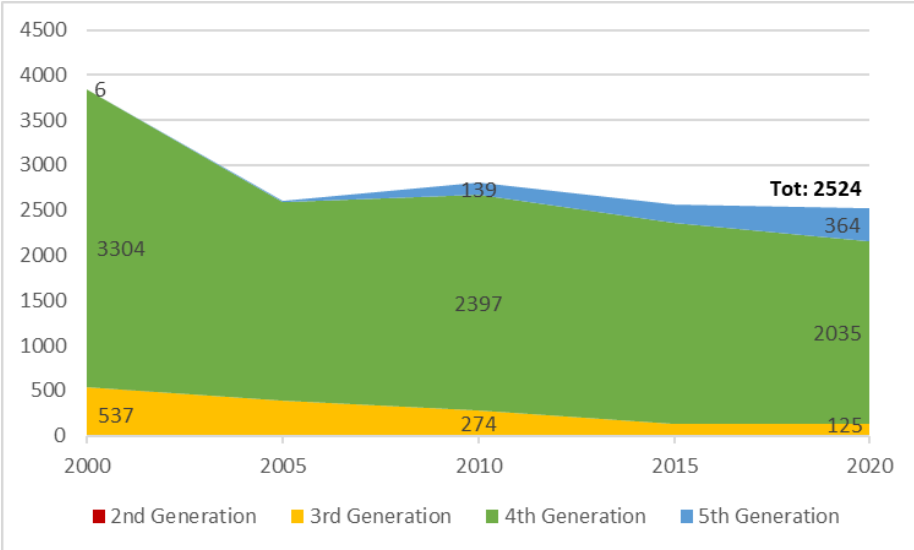

Figure D.3: US Air Force, Navy and Marine Corp combat aircraft by generation, 2000-2020. Source: IISS

5th Generation include types; F-35A/B/C, F-22. 4th Generation includes; F-18E/F, F-18A/B/C/D, F-111, F-16A/B/C/D, F-15E, F-15A/B/C/D, OA-10A/A-10C. 3rd Generation includes; F-14A/B/D, AV/TAV-8, A-10A. 2nd Generation includes; none.

Table D.3: US Air Force, Navy and Marine Corp modern combat aircraft performance, 2000-2020. Source: IISS, FOI.

Type	Gen	No. Hard-points*	Range (Km)	Speed (Km/h)	Quant. 2000	Quant. 2020
F-35A Lightning II	5	10(4)	2200	1960	0	316
F-22 Raptor	5	12(8)	>3000	2470	6	159
F-18E/F Super Hornet	+4	11	3333	2205	14	584
F-18C/D Hornet	4	11	3333	2205	1005	314
F-16 Fighting Falcon	4	9	3222	2470	1420	553
F-15E Strike Eagle	+4	11	3840	3018	210	211
F-15 Eagle	4	11	**5745	2470	494	105
OA-10A Thunderbolt	4	9	1287	676	109	143
Total (Modern)	**N/A**	**N/A**	**N/A**	**N/A**	**3304**	**2035**
Total (All)	**N/A**	**N/A**	**N/A**	**N/A**	**3847**	**2524**

* Number of missiles carried internally marked with parenthesis.

** Range of F-15 Eagle with external fuel tank.

China

PLA Navy Surface Combatants

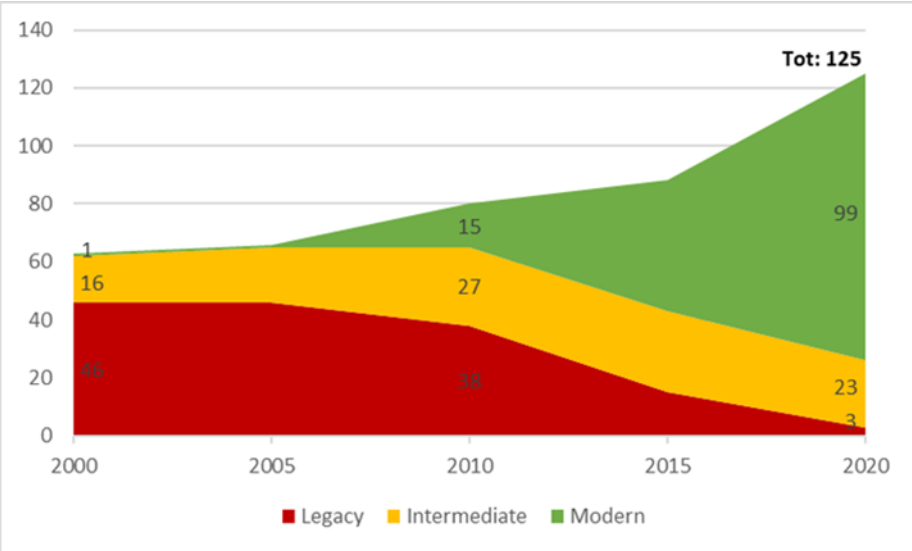

Figure D.4: PLA Navy surface combatants by modernity, 2000-2020. Source: IISS

Modern include classes of aircraft carrier; Type 001, destroyers; Type 055, Type 052D, Type 052C, Type 052B, Type 051C, Type 051B, frigates; Type 054A, Type 054, corvettes; Type 056/A. Intermediate includes destroyers; Sovremenny, Type 052, frigates; Type 053H3, Type 053H2G, Type 053H1G/H1Q. Legacy includes destroyers; Type 051/D/G, frigates; Type 053H/H1/H2.

Table D.4: PLA Navy modern surface combatant performance, 2020. Source: IISS, FOI.

Class	No. Mis-siles	SAM Range/ Speed	ASM Range/ Speed	ASW TT/ Hel.	Quant. 2000	Quant. 2020
Type 055	112	150/4.2	540/*3.0	6/2	0	1
Type 052D	64	150/4.2	540/*3.0	6/1	0	11
Type 052C	56	102/4.2	278/0.8	6/1	0	6
Type 052B	64	40/3.0	278/0.8	6/1	0	2
Type 051C	56	90/4.0	278/0.8	6/1	0	2
Type 051B	48	40/3.0	278/0.8	6/2	1	1
Type 054A	40	40/3.0	278/0.8	6/1	0	30
Type 054	16	15/2.3	278/0.8	6/1	0	2
Type 056/A	4	-/-	278/0.8	6/-	0	43
Total (Modern)	**2,844**	**N/A**	**N/A**	**N/A**	**1**	**99**
Total (All)	**3,368**	**N/A**	**N/A**	**N/A**	**67**	**125**

* The YJ-18 ASM has a flight speed of Mach 0.8 and terminal attack speed of Mach 3.0.

Type 055 and Type 052D are equipped with HHQ-9ER surface-to-air missile (SAM) and YJ-18A anti-ship missile (ASM), all other surface combatants have YJ-62 ASM. Type 052C has HHQ-9 SAM. Type 051C has S-300F. Type 52B, Type 51B and Type 054A have HHQ-16 SAM. Type 054 has HHQ-7 SAM.

PLA Army Main Battle Tanks

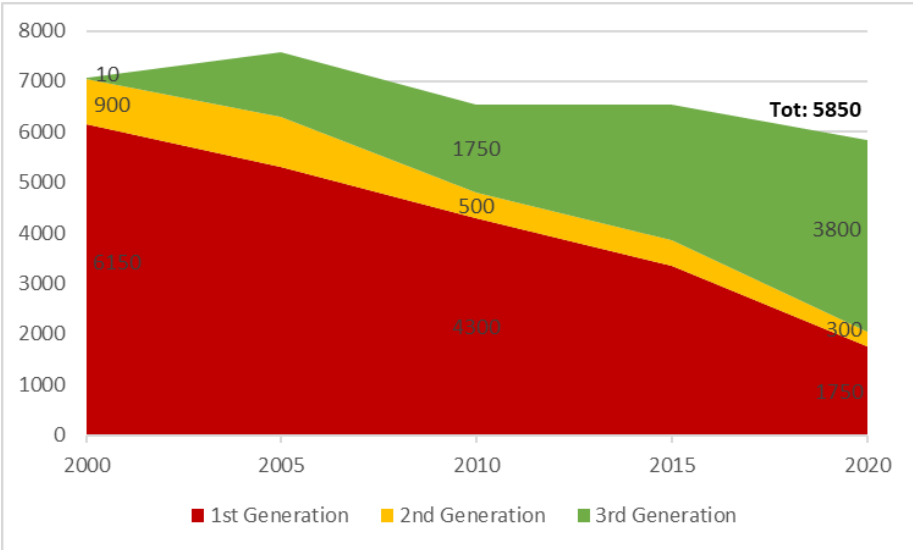

Figure D.5: PLA Army main battle tanks by generation, 2000-2020. Source: IISS

3rd Generation include types; ZTZ-99A, ZTZ-99, ZTZ-96/A, ZTZ-15. 2nd Generation includes; ZTZ-88A/B/C. 1st Generation includes; ZTZ-79, ZTZ-69-I, ZTZ-59/-I/-II/-D.

Table D.5: PLA Army modern main battle tank performance, 2000-2020. Source: IISS, FOI.

Type	Gen	Firepower (mm RHAe)	Armour (mm RHAe)	Mobility (HP/ tonne)	Quantity 2000	Quantity 2020
ZTZ-99A	+3	800	990	25.9	0	500
ZTZ-99	3	660	840	22.6	10	600
ZTZ-96A	-3	660	780	18.6	0	1500
ZTZ-96	-3	660	-	18.1	some	1000
ZTZ-15	3	-	-	-	0	200
Total (Modern)	**N/A**	**N/A**	**N/A**	**N/A**	**10**	**3800**
Total (All)	**N/A**	**N/A**	**N/A**	**N/A**	**7060**	**5850**

For reference, the slightly upgraded legacy main battle tank ZTZ-59-II has a firepower of 460 mm RHAe, protection of 203 mm RHAe and mobility value of 14 horsepower per tonne, far less than modern third generation tanks.

PLA Air Force and Navy Combat Aircraft

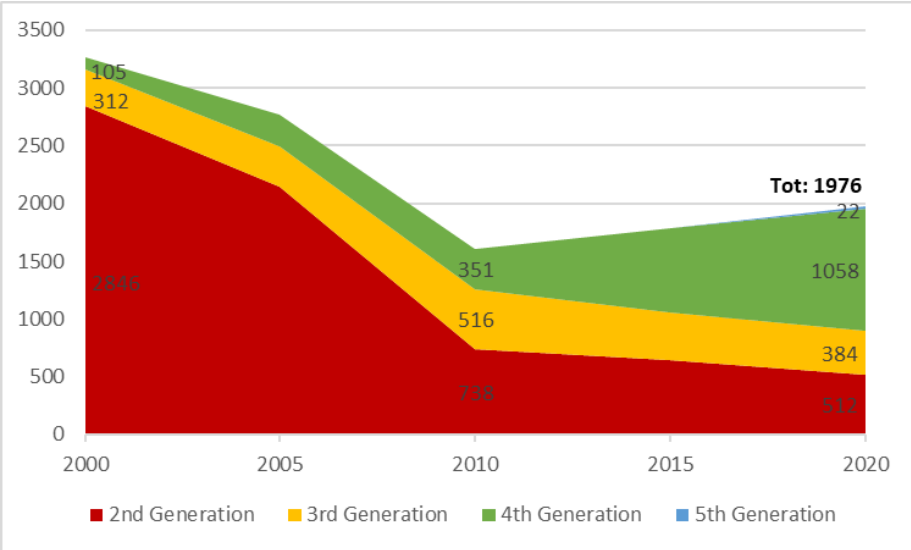

Figure D.6: PLA Air Force and Navy combat aircraft by generation, 2000-2020. Source: IISS.

5th Generation include types; J-20. 4th Generation includes; J-16, J-15, J-10S/B/C, J-10/A, Su-35, Su-30MKK/MK2, J-11B/BS, J-11/Su-27. 3rd Generation includes; JH-7/A, J-8A/B/E. 1st Generation includes; J-7/II/III/E, Q-5/C/D/E, J-6/B/C/D/E.

Table D.6: PLA Air Force and Navy modern combat aircraft performance, 2000-2020. Source: IISS, FOI.

Type	Gen	No. Hard-points*	Range (Km)	Speed (Km/h)	Quant. 2000	Quant. 2020
J-20 Mighty Dragon	5	10(6)	3400	2100	0	22
J-16	+4	12	3000	2450	0	100
J-15 Flying Shark	4	12	3500	2100	0	20
J-10 Vigorous Dragon	4	11	1850	2327	0	445
Su-35	+4	12	3600	2390	0	24
Su-30	4	12	3000	2150	40	97
J-11B/BS	4	10	3530	2100	0	202
J-11/Su-27	4	10	3530	2100	65	147
Total (Modern)	**N/A**	**N/A**	**N/A**	**N/A**	**105**	**1080**
Total (All)	**N/A**	**N/A**	**N/A**	**N/A**	**3263**	**1976**

* Number of missiles carried internally marked with parenthesis.

European Four

French, German, UK and Italian Navy Surface Combatants

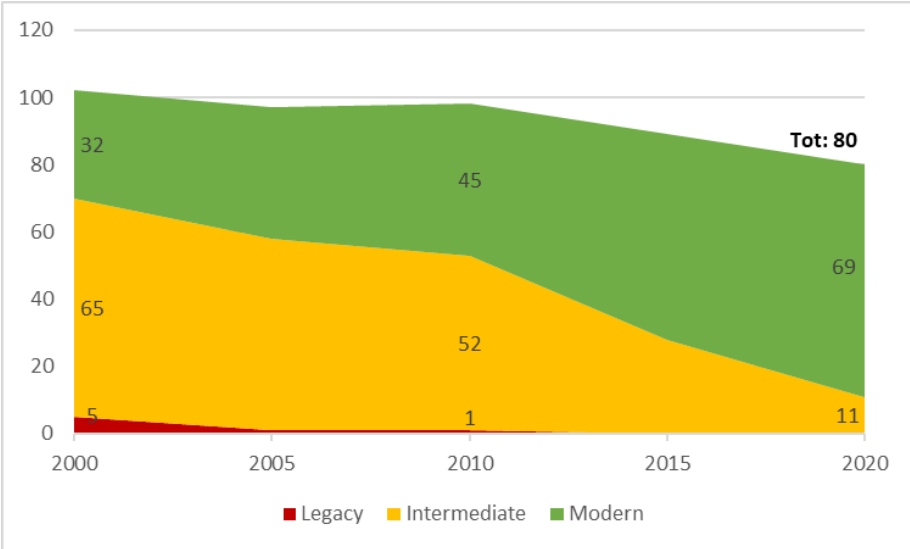

Figure D.7: E4 Navy surface combatants by modernity, 2000-2020. Source: IISS

Modern include classes of aircraft carrier; Charles de Gaulle, Queen Elizabeth, Cavour, amphibious assault ship; Mistral, destroyers; Aquitaine, Forbin, Type 45, Andrea Doria, Durand de la Penne, frigates; La Fayette, Floreal, Sachsen, Brandenburg, Type 23, Bergamini, corvettes; Braunschweig. Intermediate includes aircraft carrier; Invincible, Guiseppe Garabaldi, destroyers; Cassard, Georges Leygues, Tourville, Type 42, Audace, frigates; Bremen, Type 22, Maestrale, Artiglieri, Lupo, corvettes; Minerva. Legacy includes aircraft carrier; Clémenceau, cruisers; Jeanne d'Arc, Vittorio Veneto, destroyers; Lütjens.

Table D.7: E4 Navy modern surface combatant performance, 2020. Source: IISS, FOI.

Class	No. Mis-siles	SAM Range/ Speed	ASM Range/ Speed	ASW TT/ Hel.	Quant. 2000	Quant. 2020
Aquitaine (FREMM)	40	30/3.0	180/0.9	4/1	0	6
Forbin	56	100/4.5	180.0.9	4/1	2	2
Type 45 Daring	56	100/4.5	240/0.9	4/1	0	6
Andrea Doria	56	100/4.5	180/0.9	2/1	0	2
Durand de la Penne	16	25/3.7	180/0.9	6/2	2	2
La Fayette	12	16/3.5	180/0.9	-/1	4	5
Floreal	4	-/2.6	40/0.9	-/1	6	6
Baden-Württemberg	8	-/-	120/0.9	-/2	0	1
Sachsen	40	170/3.5	120/0.9	6/2	0	3
Brandenburg	20	50/4.0	40/0.9	4/2	4	4
Type 23 Duke	40	10/2.0	240/0.9	4/2	14	13

Bergamini (FREMM)	20	100/4.5	180/0.9	6/2	0	8
Braunschweig	4	-/-	200/0.9	-/-	0	5
Total (Modern)	**1,880**	**N/A**	**N/A**	**N/A**	**32**	**69**
Total (All)	**1,956**	**N/A**	**N/A**	**N/A**	**102**	**80**

Aquitaine is equipped with Aster 15 surface-to-air missile (SAM). Forbin, Daring, Andrea Doria and Bergamini have Aster 30 SAM. Durand de la Penne has Aspide SAM. La Fayette has Crotale SAM. Floreal has Mistral SAM. Sachsen has SM-2 Block III SAM. Brandenburg has Sea Sparrow SAM. Aquitaine, Forbin and La Fayette have MM40 Exocet anti-ship missile (ASM). Sachsen has Harpoon Block IB ASM. Floreal and Brandenburg have MM38 Exocet ASM. Daring and Duke have Harpoon Block IC ASM. Andrea Doria, Durand de la Penne and Bergamini have Otomat Mk2 ASM. Braunschweig has RBS15 Mk3 ASM.

French, German, UK and Italian Army Main Battle Tanks

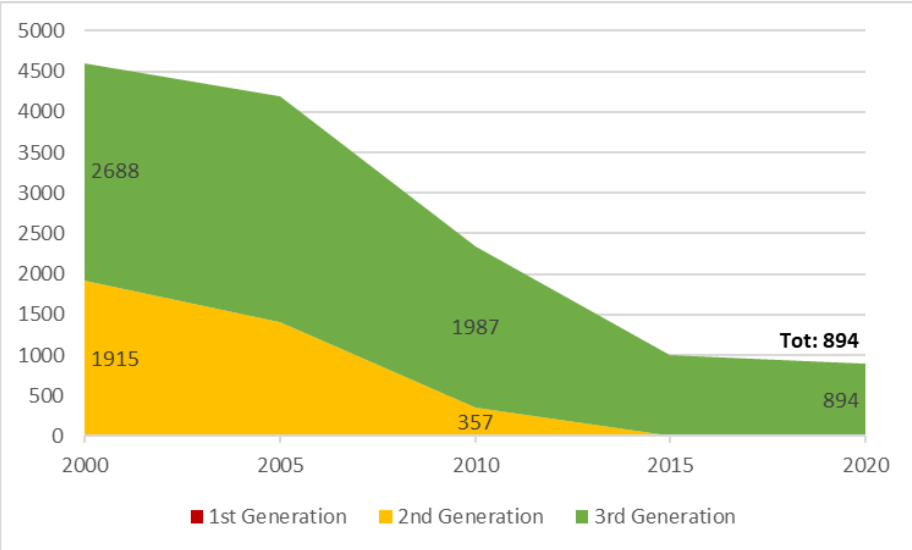

Figure D.8: E4 Army main battle tanks by generation, 2000-2020. Source: IISS.

3rd Generation include types; Leclerc, Leopard 2A7/A6/A4, Challenger 2, Challenger 1, C1 Ariete. 2nd Generation includes; AMX-30, Leopard 1, Chieftain.

Table D.8: E4 Army modern main battle tank performance, 2020. Source: IISS, FOI.

Type	Gen	Firepower (mm RHAe)	Armour (mm RHAe)	Mobility (HP/ tonne)	Quantity 2000	Quantity 2020
Leclerc	+3	690	890	26.6	199	222
Leopard 2A7	+3	-	-	-	0	20
*Leopard 2A6**	+3	750	970	24.0	0	225

Leopard 2A4	3	600	700	27.2	1782	0
Challenger 2	+3	610	1250	19.2	192	227
Challenger 1	3	-	-	-	410	0
C1 Ariete	3	-	-	-	105	200
Total	**N/A**	**N/A**	**N/A**	**N/A**	**4603**	**894**

* Data actually represent the older Leopard 2A5 version, exported to e.g. Denmark and Sweden.

French, German, UK and Italian Air Force and Navy Combat Aircraft

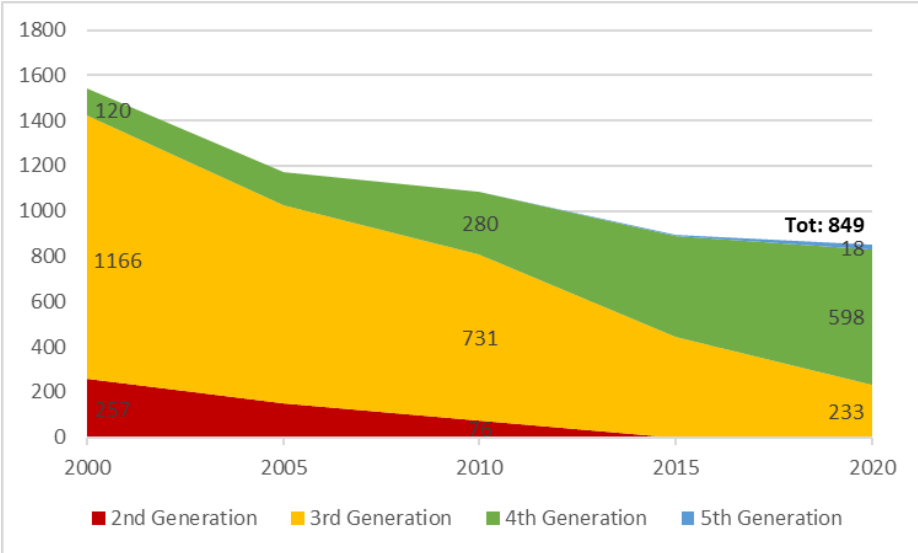

Figure D.9: E4 Air Force and Navy combat aircraft by generation, 2000-2020. Source: IISS.

5th Generation include types; F-35B. 4th Generation includes; Rafale B/C, Rafale M, Mirage 2000D/N, Eurofighter, F-16, 3rd Generation includes; Mirage 2000B/C, Mirage F-1, Super Etard, Jaguar, Tornado, MiG-29, Harrier, Ghibli. 2nd Generation includes; F-4, Su-22, F-104, MiG-23, MiG-21.

Table D.9: E4 Air Force and Navy modern combat aircraft performance, 2020. Source: IISS, FOI.

Type	**Gen.**	**No. Hard-points***	**Range (Km)**	**Speed (Km/h)**	**Quant. 2000**	**Quant. 2020**
F-35B Lightning II	5	10(4)	1667	1960	0	18
Rafale B/C	+4	14	3125	2205	0	100
Mirage 2000 D/N	4	9	3335	2530	120	66
Eurofighter Typhoon	+4	13	3790	2470	0	377
Total (Modern)	**N/A**	**N/A**	**N/A**	**N/A**	**120**	**616**
Total (All)	**N/A**	**N/A**	**N/A**	**N/A**	**1543**	**849**

* Number of missiles carried internally marked with parenthesis.

Russia

Russian Navy Surface Combatants

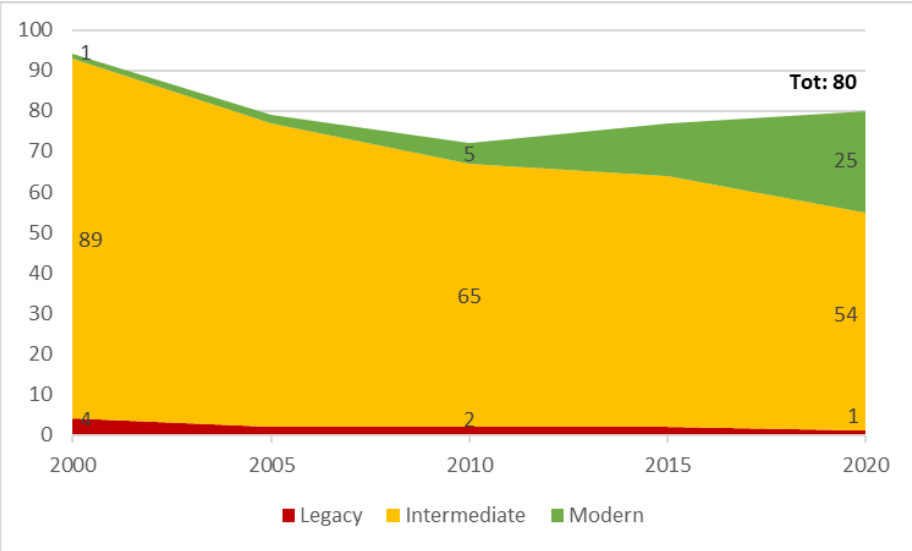

Figure D.10: Russian Navy surface combatants by modernity, 2000-2020. Source: IISS

Modern include classes of frigates; Gorshkov, Krivak V, Gepard, Neustrashimyy, corvettes; Steregushchiy, Buyan/M. Intermediate includes aircraft carrier; Kuznetsov, cruisers; Kirov, Slava, destroyers; Udaloy I/II, Sovremenny, frigates; Krivak II, Krivak I, corvettes; Parchim II, Grisha I/III/IV/V, Nanuchka III/IV. Legacy includes cruisers; Kara, Kynda, destroyers; Kashin mod., Kashin.

Table D.10: Russian Navy modern surface combatant performance, 2020. Source: IISS, FOI.

Class	No. Missiles	SAM Range/ Speed	ASM Range/ Speed	ASW TT/ Hel.	Quant. 2000	Quant. 2020
Gorshkov	48	150/6.0	300/2.4	8/1	0	1
Grigorovich	32	50/4.0	300/2.4	4/1	0	3
Gepard	18	-/-	300/3.0	4/1	0	2
Neustrashimiy	40	12/2.0	130/0.8	6/1	1	2
Kurakurt	8	-/-	-/-	-/-	0	1
Steregushchiy	20	50/2.6	130/0.8	8/1	0	6
Buyan-M	20	-/-	300/3.0	-/-	0	10
Total (Modern)	**588**	**N/A**	**N/A**	**N/A**	**8**	**39**
Total (All)	**1,880**	**N/A**	**N/A**	**N/A**	**156**	**129**

Gorshkov is equipped with 9M96 Poliment-Redut surface-to-air missile (SAM). Grigorovich has 9M317E Shtil-1 SAM. Neustrashimiy has 3K95 Kinzhal SAM.

Steregushchiy has 9M96M Poliment-Redut SAM. Gorshkov and Grigorivich have P-800 Onyx anti-ship missile (ASM). Gepard and Buyan-M have 3M54 Sizzler ASM. Neustrashimiy and Steregushchiy have 3M24 Uran ASM. Karakurt corvettes carry land-attack cruise Klub-missiles, so far not verified as ASM-capable.

Russian Army Main Battle Tanks

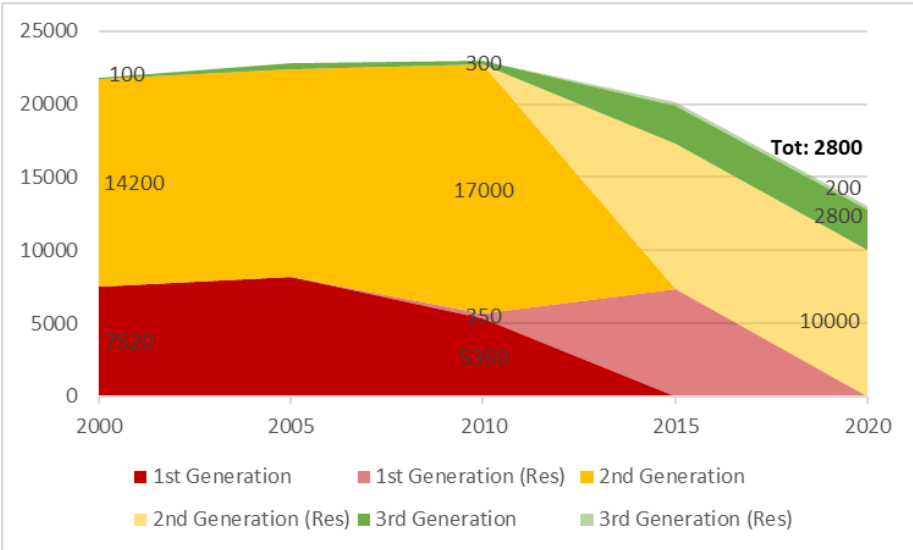

Figure D.11: Russian Army main battle tanks by generation, 2000-2020. Source: IISS.

3rd Generation include types; T-90/A, T-80BVM, T-80BV/U, T-72B3, T-72B/BA. 2nd Generation includes; T-80/U/UD/UM, T-72/L/M. 1st Generation includes; T-64A/B, T-62, T-55. A large share of Russian main battle tanks are currently held in reserve. 3rd Generation in reserve includes; T-90/A. 2nd Generation in reserve includes; various versions of T-80, various versions of T-72. 1st Generation in reserve includes; T-64A/B, T-62, T-55.

Table D.11: Russian Army modern main battle tank performance, 2020. Source: IISS, FOI.

Type	Gen	Firepower (mm RHAe)	Armour (mm RHAe)	Mobility (HP/ tonne)	Quantity 2000	Quantity 2020
T-90A	+3	660	840	23.7	100	350
T-80BVM	3	-	-	-	0	120
T-80BV/U	3	630	-	27.2	0	330
T-72B3/B3 mod.	-3	660	780	18.9	0	1350
Total (Modern)	**N/A**	**N/A**	**N/A**	**N/A**	**21820**	**2800**
Total (All active)	**N/A**	**N/A**	**N/A**	**N/A**	**21820**	**2800**

Russian Air Force and Navy Combat Aircraft

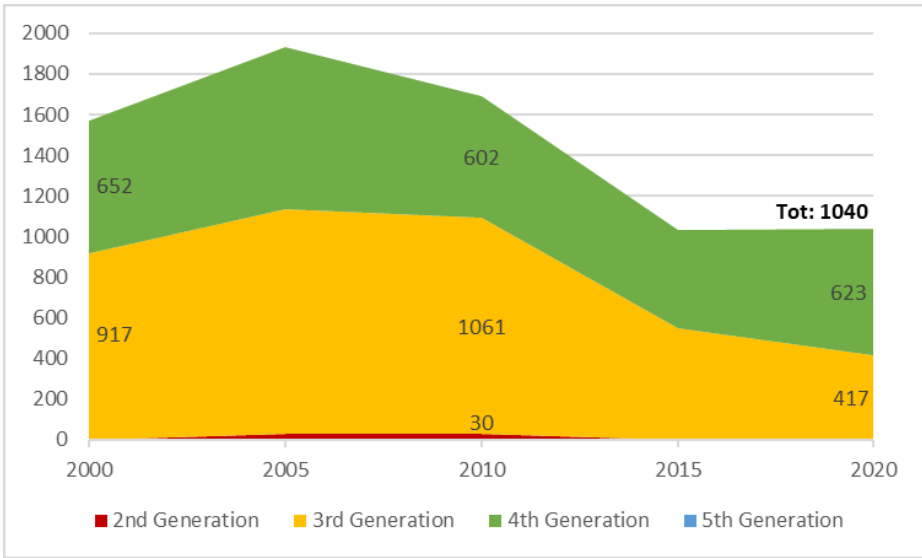

Figure D.12: Russian Air Force and Navy combat aircraft by generation, 2000-2020. Source: IISS.

5th Generation include types; none. 4th Generation includes; Su-35S, Su-34, Su-30/M2/SM, Su-27/UB/SM2/SM3, MiG-29. 3rd Generation includes; Su-25A/SM/UB, Su-24, MiG-31. 2nd Generation includes; MiG-25A/E.

Table D.12: Russian Air Force and Navy modern combat aircraft performance, 2020. Source: IISS, FOI.

Type	Gen.	No. Hard-points	Range (Km)	Speed (Km/h)	Quant. 2000	Quant. 2020
Su-35S Flanker-E	+4	12	3600	2390	0	90
Su-34 Fullback	+4	10	*4500	1900	0	122
Su-33 Flanker-D	4	12	3000	2300	0	17
Su-30/M2/SM	4	12	3000	2150	0	133
Su-27/UB/SM2/SM3	4	10	3680	2879	392	119
MiG-29	4	7	2100	2400	260	142
Total (Modern)	**N/A**	**N/A**	**N/A**	**N/A**	**652**	**623**
Total (All)	**N/A**	**N/A**	**N/A**	**N/A**	**1569**	**1040**

* Range of Su-34 Fullback with external fuel tank.

The figures in this report differs from Russia's own assessment of modern equipment.[65] The largest discrepancy between this report's and Russia's own assessment is among surface combatants. This difference is likely due to different definitions of the term "modern". While his report only includes new equipment, Russia may include upgraded equipment, but this has not been confirmed.

Russian Estimates of Modern Equipment

Table D.13: Reported share of modern equipment (2020 = Target).

Type/Year	2013	2015	2017	*2020*
Surface Combatants	41%	44%	54%	*71%*
Aircraft	23%	37%	55%	*71%*
Armoured Vehicles	20%	37%	56%	*82%*

Regarding armoured vehicles it is difficult to identify the cause of the discrepancy since the Russian estimates on this type of system is not directly comparable to the Main battle tanks categorised in this report. It is also worth noting that while the Russian estimates on aircraft seem to correspond fairly well with this report's estimates on combat aircraft, these estimates may still include different types of aircraft.

[65] Collected from Connolly, Richard & Sendstad, Cecilie (2017) "Russia's Role as an Arms Exporter – The Strategic and Economic Importance of Arms Exports for Russia". Research Paper, *Chatham House*.

Appendix E: Future Trends

Estimates of future trends presented in the tables of Appendix E includes macroeconomic trends and equipment quantities for major world power navies, between 2020 and 2030. The methods, assumptions and data which form the basis for these estimates are described in detail in this appendix. Assessments of future military expenditure, quantities of army and air force equipment as well as military equipment quality are not quantified. Instead, these trends are discussed in terms of likely developments and factors which may impact the direction of these developments between 2020 and 2030.

GDP for 2019 have been collected from the World Bank (2020), presented in constant 2010 USD. Estimates for 2020 to 2025 have been collected from the latest IMF projections.[66] These project a sharp downturn in the world economy in 2020 followed by steady recovery from 2021 to 2025, see Table E.1

Table E.1: Future GDP and growth estimates, constant 2010 USD. Source: World Bank (2020a), IMF (2020a), CBO (2020), World Bank (2013).

Country	GDP 2019 (Billion USD)	Change 2019-20 (%)	Change 2020-21 (%)	Average Change 2022-25 (%)	Average Change 2026-30 (%)	GDP 2030 (Billion USD)
US	18,319	-4.3	+3.1	+2.2	+2.1	21,898
China	11,537	+1.9	+8.2	+5.7	+5.0	20,227
Eurozone	14,179	-8.3	+5.2	+2.1	+1.6	16,090
Russia	1,762	-4.1	+2.8	+2.0	2.0	2,080
India	2,964	-10.3	+8.8	+7.6	7.0	5,428
World	**84,990**	**-4.4**	**+5.2**	**+3.8**	**-**	**-**

US long-term GDP is based on a CBO report from July 2020 which estimates a growth rate of 2.1 percent from 2026 to 2030.[67] Meanwhile, Chinese GDP is based on earlier projections made by the World Bank in 2013 and estimates growth rate of 5 percent from 2026 to 2030.[68] If these estimates were to be realised, China would surpass the US to become the world's largest economy in terms of market exchange rate around 2033.[69]

For the Eurozone, Russia and India, macroeconomic forecasts proved more difficult to obtain. Instead, the growth rates of the past decade have been prolonged

[66] IMF (2020a) *World Economic Outlook Database*. (Accessed 23 November 2020).
[67] Congressional Budget Office (2020) *An Update to the Economic Outlook: 2020 to 2030*. June 2020, p. 3.
[68] World Bank (2013) *China 2030: Building a Modern, Harmonious, and Creative Society*, p. 9. For estimates on the Eurozone, Russia and India see historical data from the World Bank.
[69] This assessment is supported by a report from PricewaterhouseCooper (2015) *The World in 2050 – Will the shift in global economic power continue?* February 2015, p. 11. This projection assumes that China will surpass the US by 2027.

with some adjustments to serve as rough estimates of future trends. Based on this simplified assumption, this study expects the Eurozone to grow by 1.6 percent over the whole period 2026-2030. By the same logic, Russia's GDP is assumed to grow by 2.0 percent from 2022 to 2030. India is estimated to grow by 7.0 percent from 2026 to 2030. Some estimates put this rate higher, but such predictions also depend on the success of several reforms.[70]

Future military expenditure among major world powers depends on two factors, the future GDP of each country and the priority each country gives to military expenditure as share of GDP. No estimates of the future military expenditure are presented in this report, but Chapter 4 discusses how future military spending for major world powers would look if military expenditure as share of GDP would remain the same in 2030 as in 2020.

Estimates of future quantities of military equipment is limited to the navies of major world powers. Hulls of ships and submarines are usually constructed several years before being commissioned into service. As a result, the method of estimating quantities of future naval vessels in active service is relatively straight forward. Data on the number of launched ships are regularly updated in open sources. In this study, ships and submarines launched by 2020 are assumed to be taken into active service by 2025. Similarly, the ships and submarines laid down or officially planned, but not yet launched, are assumed to be commissioned by 2030. The US is one of few countries with an official plan for its future navy, the so called 355-ship navy. This plan states that the US should have a fleet of 355 vessels, including support ships, by 2034.[71] Even though the feasibility of this ambitious plan has come into question, this study still uses the 355-ship navy as a benchmark for estimating the future quantities of US naval vessels.

Given that the 355-ship ambition is actually realised, the US is expected to have 163 surface combatants and 56 submarines by 2030, see Table E.2. Most of the increase in surface combatant will most likely be made up by Arleigh Burke Flight IIA and III destroyers, Independence and Freedom littoral combat ships (LCSs) and a future class of frigates, while the number of aircraft carriers and amphibious assault ships will remain stable as the Ford class and the America class replace older aircraft carriers and amphibious assault ships respectively. Meanwhile, the number of US submarines is planned to decrease between 2020 and 2030, as the Virginia class does not fully compensate for the decommissioning of older Los Angeles submarines.

[70] See e.g. PricewaterhouseCooper (2014) *Future of India – The Winning Leap*.

[71] Note that the cited numbers are given for fiscal years, most likely at the end of a given year. In order to make these numbers comparable with IISS data, which refer to quantities in the beginning of each year, numbers for fiscal year 2029 (FY29) are used for the year 2030. Congressional Research Service (2020) *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*.

Table E.2: US Navy future surface combatants and submarines, 2020-2030. Source: IISS (2020), FOI.

Class/Year	2020	2025	2030
Aircraft Carriers	11	11	10
Amphibious Assault Ships	9	10	11
Cruisers	22	15	16
Destroyers	69	79	88
LCSs/Frigates	19	28	38
Strategic Nuclear Submarines	14	14	12
Tactical Nuclear Submarines	53	51	44
Total	**197**	**208**	**219**

The source for these data only provided the total number in service and the number of ships delivered each year. The number of ships decommissioned could be estimated by adding the number of new ships to the current quantity and subtracting the number of future ships. Note that the data, which form the basis for these estimates, only states whether the ship is a large or small surface combatant but does not distinguish between cruisers, destroyers, frigates or littoral combat ships. The future quantity of e.g. cruisers and destroyers in this study therefore had to be estimated using available open data on ship construction to discern which ships were most likely to be commissioned, and information on age to discern which ships were most likely to be decommissioned.

The Chinese PLA Navy seems set to continue the rapid expansion of previous decades, see Table E.3. These estimates may seem high, but are not far-fetched, since a vast majority of the vessels included in table estimates were already launched by mid-2020 and will likely be taken into service by 2025.

Table E.3: PLA Navy future surface combatants and submarines, 2020-2030. Source: IISS (2020), FOI.

Class/Year	2020	2025	2030
Aircraft Carriers	1	2	4
Amphibious Assault Ships	0	2	3
Destroyers	31	48	59
Frigates	50	43	42
Corvettes	43	72	72
Strategic Nuclear Submarines	4	6	8
Tactical Nuclear Submarines	6	10	13
Tactical Conventional Subs	48	48	46
Total	**183**	**232**	**247**

After 2025, the pace of expansion for the PLA Navy is assumed to decrease, as maintenance costs for the larger and more modern vessels increase and the growth of military expenditure likely slows as economic growth decelerates. Nonetheless, this study estimates that the PLA Navy will consist of 180 surface combatant and 67 submarines by 2030. The increase in number of vessels includes all types of

surface combatant, but up until 2025 a large share is made up of corvettes. Given that the production of the Type 056 corvettes and Type 054 frigates had stopped by 2020, the focus will likely shift to larger surface combatants after 2025. These include Type 75 amphibious assault ships, Type 055 and Type 052D destroyers as well as two new aircraft carriers, larger and more capable than the ones currently in service.[72] China is also likely to increase the number of nuclear submarines, both strategic and tactical, while the number of conventional submarines is likely to remain more stable. However, the PLA Navy submarine force is one of the most secretive parts of China's Armed Forces and as a consequence, estimates of its future size are highly uncertain.

Table E.4: E4 Navy future surface combatants and submarines, 2020-2030. Source: IISS (2020), FOI.

Class/Year	**2020**	**2025**	**2030**
Aircraft Carriers	4	4	4
Amphibious Assault Ships	3	4	4
Destroyers	21	18	18
Frigates	47	42	39
Corvettes	5	11	17
Strategic Nuclear Submarines	8	8	8
Tactical Nuclear Submarines	11	12	13
Tactical Conventional Subs	11	14	16
Total	**110**	**113**	**119**

The French, German, UK and Italian navies are likely to slow and even reverse the trend over the past decades with falling quantities of naval vessels, see Table E.4. This study estimates that the combined navies of the four European powers will consist of 82 surface combatants and 37 submarines in 2030. However, the number of large surface combatants are actually estimated to decrease slightly as older classes of French and Italian destroyers are nearing the end of their life-cycle without any immediate replacements. Meanwhile, the French Aquitaine, German Baden-Württemberg and future MKS180, UK Type 26 and Type 31, and Italian frigates taken will not fully replace older classes on a one-to-one basis.[73] Most of the increase is instead attributable to the growing number of German Braunschweig and Italian Paolo Thaon di Revel corvettes. The quantity of submarines will increase slightly as 6 new French Barracuda, 2 additional to the 6 existing German Type 212, a total of 7 UK Astute, and 8 Italian Todaro submarines replace older vessels.

[72] The Chinese aircraft carrier Shandong was actually taken into active service, besides the Liaoning, in late 2019, but not accounted for by IISS (2020).

[73] New E4 frigate classes in this study include the French Frégates de taille intermediare (FTI), the German future MKS 180, the Royal Navy Type 26 and Type 31 as well as the rest of the Italian Bergamini class (FREMM) frigates. Older ships set to retire between 2020 and 2030 include the French La Fayette and Floreal, German Bremen and Brandenburg, UK Type 23 and Italian Maestrale frigates.

Table E.5: Russian Navy future surface combatants and submarines, 2020-2030. Source: IISS (2020), FOI.

Class/Year	2020	2025	2030
Aircraft Carriers	0	1	1
Amphibious Assault Ships	0	1	2
Cruisers	4	4	5
Destroyers	12	10	10
Frigates	10	12	16
Corvettes	54	55	55
Strategic Nuclear Submarines	10	10	12
Tactical Nuclear Submarines	17	19	18
Tactical Conventional Subs	22	25	26
Total	**129**	**137**	**145**

The Russian navy is estimated to increase its overall quantity of vessels, see Table E.5. In 2030, this study estimates that the Russian Navy have 89 surface combatants and 56 submarines. This increase includes nearly every type of ship and submarine, but most new ships will consist of smaller surface combatants. The stable number of corvettes hides the fact that a large number of these older vessels, such as Grisha and Nanuchka, will be replaced by new ones, such as Merkuriy and Karakurt, until 2030. Similarly, Admiral Gorshkov and Admiral Grigorovich class frigates are set to replace older Krivak I and II frigates. Larger surface combatants will continue to consist of updated Soviet era Kirov and Slava class cruisers, Sovremenny and Udaloy destroyers, and the refurbished aircraft carrier Admiral Kuznetsov. The large Lider class destroyers seems to be postponed indefinitely. The only exemption is the newly produced Priboy class amphibious assault ships. The quantity of submarines is likely to increase somewhat as older Kilo 877 Paltus conventional submarines are replaced by newer Kilo 636.3 Varshavyanka and further Graney 885M Yasen nuclear submarines are introduced. The number of strategic nuclear Dolorukiy 955 Borey submarines are likely to increase to 12 by 2030, from 10 in 2020, replacing older Delta IV and Delta III submarines.

Future navy tonnage and missiles capabilities may also shed additional light in future power relations, see Table E.6. The data are derived from a number of open sources including, but not limited to, various volumes of IISS *The Military Balance*. Note that aircraft carriers are not included in the overall missile count, as their missile capabilities almost exclusively rest with the number of combat aircraft carried. The estimates of this study shows that the US Navy surface tonnage and missile capability will remain relatively stable, at between 2,400 to 2,600 and 9,600 to 10,600 missiles, between 2020 and 2030. As China focuses on larger surface ships, both tonnage and missiles numbers will outpace the growth in ship numbers, tonnage will more than double and missile capability increase by about 76 percent. If these estimates hold, then the PLA Navy is set to reach nearly half the tonnage and over half the missile capability of the US Navy in 2030.

Table E.6: Future naval tonnage and missile capabilities among major world powers, 2020-2030. Sources: IISS (2020), FOI.

Country	Factor	2020	2025	2030
US	Total tonnage (1000 tonnes)	3,098	3,207	3,171
	Surface tonnage (1000 tonnes)	2,421	2,529	2,608
	Surface missiles (number of)	9,676	9,686	10,644
China	Total tonnage (1000 tonnes)	733	1,219	1,506
	Surface tonnage (1000 tonnes)	503	927	1,175
	Surface missiles (number of)	3,368	5,000	5,920
E4	Total tonnage (1000 tonnes)	767	856	972
	Surface tonnage (1000 tonnes)	574	644	735
	Surface missiles (number of)	1,956	1,896	2,144
Russia	Total tonnage (1000 tonnes)	671	735	967
	Surface tonnage (1000 tonnes)	248	256	416
	Surface missiles (number of)	1,880	2,100	2,564

While the French, German, UK and Italian fleets will increase marginally in terms of ship numbers, those ships have an average greater tonnage, which is estimated to increase by 28 percent between 2020 and 2030. However, since many of the new ships taken into service during these period are lightly armed frigates and corvettes, this increase in tonnage does not translate to a similar increase in missiles. Similarly, while the Russian Navy is set to increase the number of surface combatants only marginally by 2030, its tonnage and number of missiles will grow far more substantially. However, these assertions rely heavily on the assumption that both of the Kirov class battlecruisers and all three of the Slava class cruisers will be in active service by that year.

Assumptions about future armies and air forces are more difficult than navies, as ground equipment and aircraft quantities can shift more quickly compared to naval platforms. No exact estimates are given in this study, instead a qualitative discussion about plausible future trends in provided in Chapter 4.

Data on future economic and military trends have been collected from a wide range of open sources, such as international institutes, government agencies or online news outlets with a military focus. These data are referred to collectively as “FOI” in the tables above, see Section 2.1 for details. Such open source data should be treated with degree of caution and viewed as broad assessments rather than exact predictions.

This report is the third in the biennial series Defence Economic Outlook (DEO), published by the Swedish Defence Research Agency (FOI). Defence Economic Outlook 2020 provides an assessment of the global power balance in terms of military expenditure, macroeconomic trends, and quantities as well as quality of military equipment among major world powers between 2010 and 2019. The report also aims to provide a broad assessment of future trends with regard to the same aspects from 2020 to 2030.

The global military and economic power balance has changed significantly during the past decade. While the US and its European allies still possess a clear military advantage, major non-Western powers such as China and Russia have steadily narrowed this gap. The past decade, China's share of global military spending as well as its share of the world economy has increased considerably. In recent years, the US and several European countries have refocused their attention towards great power rivalry and increased their military spending. This may slow, but is unlikely to reverse, the observed trends of the past decade.

It is the assessment of this study that the US will continue to enjoy an overall military advantage in 2030. However, the Chinese economy is likely to become the world's largest, and the Chinese navy will likely outnumber its US counter-part, around the same time. Continued growth of European military expenditure is far from certain, however, the Eurozone's economic advantage over Russia seems set to increase. Nevertheless, Russia is likely to retain and even strengthen its military capabilities. These assessments are not predetermined, nor are they indisputable. They are, however, based on detailed data as well as clearly defined and motivated assumptions.

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