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The return of big numbers to the battlefield: the quantitative implications of the War in Ukraine for the Taiwan ambitions of the People's Republic of China

Abstract

The War in Ukraine has highlighted the importance of numbers in military conflicts between superpowers, demonstrating that these wars still largely adhere to the parameters of the modern era and the massive use of conventional weapons. One cannot help but wonder how these observations apply to the case of China's claims to Taiwan; arguably the most dangerous source of tension facing the world. China has a very large population base, which is the focus of this research, thus strengthening its position, and which may prove decisive on the geopolitical chessboard. Observations from the War in Ukraine urge caution and highlight the importance of not relying solely on the deterrence of US military superiority to maintain the *status quo* on the Taiwan issue. It also stresses the need for Spain and the European Union to promote policies that strengthen and consolidate their defence industries.

Keywords

Defence, Military, Conflict, China, Geopolitics.

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1 Introduction

1.1 Background and relevance of the research

The war in Ukraine has made it clear that large-scale military confrontation is not as unlikely as previously thought and has quickly generated speculation about a possible Chinese invasion of Taiwan (Qin *et al.*, 2022).

In a publication by the Center for Strategic and International Studies (CSIS), it was stated that:

> "What was once unthinkable—direct conflict between the United States and China—has now become a commonplace discussion in the national security community. [...] Taiwan is widely regarded as the most dangerous potential flashpoint for conflict between the United States and China" (Cancian *et al.*, 2023).

The Taiwan issue is complex, sensitive and entails serious risks. On one hand, this is a highly important claim by China, due to various factors such as the presence of the semiconductor industry on the island or to prevent mainland China from being geographically isolated from its outlet to the Pacific Ocean. Above all, however, this is a matter of Chinese national pride, and that makes it a particularly sensitive issue. In 2022, Xi Jinping, in his speech to the 20th Chinese Communist Party Congress, reiterated the fundamentals of China's official policy on the Taiwan issue, which is that the island is part of China and its reunification will be sought by peaceful means, but does not renounce the use of force if necessary, "consolidated commitment to the one-China principle" (Xi, 2022).

On the other hand, US commitment to Taiwan's autonomy is strong, even arguably stronger than that to Ukraine, and direct intervention in its defence would be likely (Cancian *et al.*, 2023). Along these lines, President Joe Biden told reporters that he was prepared to use force in the defence of Taiwan (Kanno-Youngs and Baker, 2022). The growing tension with China was also evident at the NATO summit in Washington in July 2024, where, in its most confrontational statement against China, it was accused of being "a decisive enabler of Russia's war against Ukraine" and of continuing to "pose systemic challenges to Euro-Atlantic security" (NATO, 2024).

While the United States leads the way in defending Taiwan's autonomy, Japan is another potentially relevant actor in this scenario. National security and alliance reforms over the last decade have elevated its strategic role in the area (Liff, 2022: 125-160); the alliance with the United States is fundamental to US military strategy in the event of a crisis situation on the island (Smith, 2022: 69-97).

Due to rising tensions and the precedent of the war in Ukraine, this issue deserves to be explored in depth, in order to gain a clearer view and avoiding misrepresentations.

This research does not take a stance on the likelihood of conflict over Taiwan but acknowledges its possibility.

Moreover, the war in Ukraine is teaching important lessons about the nature of modern warfare between powers. In contrast to the Iraq War, where fighting between the bulk of the forces resulted in a rapid US victory, largely driven by the technological superiority of its resources, in Ukraine, troop advances are much more sporadic and offensives are carried out at a very high cost in human lives and destroyed material. As a Foreign Affairs publication put it, "This war is quite familiar. It features foot soldiers trudging through muddy trenches in scenes that look more like World War I than Star Wars" (Biddle, 2023: 153-164).

The strategic observation of the war in Ukraine has shed renewed light on the importance of the massive use of conventional weaponry; the ability to innovate and adapt to new uses of warfare; and the demographic factor. It is therefore of interest to analyse these factors at the macro level, for the specific case of China and the confrontation over Taiwan.

This approach is of especial interest because, given China's large population base and considerable resources, as well as military budget, R&D spending, armed forces personnel, or innovative activities of all kinds, the balance of power may be more inclined towards China than before, and this could have very significant consequences. While it is acknowledged that the two scenarios, Ukraine and Taiwan, are very different and that every war is different from the previous one, and will be different from the next one, the lessons of Ukraine are significant because they may provide clues as to where future conflicts may evolve and influence the perception of military force at the strategic level.

1.2 Hypothesis and research objectives

The following research question was defined as the starting point and guide for this study:

What is the impact of the military strategic lessons of the war in Ukraine on the issue of Taiwan?

The hypothesis put forward in order to answer the research question and which this study will seek to confirm or refute is as follows:

The Ukrainian War demonstrates that in conflicts between powers, the quantity and volume of conventional arms production, together with the capacity to innovate in defence technologies and the demographic factor, are central elements. This phenomenon is crucial to the Taiwan issue, as China's vast production, research and population capacity can shift the perception of forces in its favour.

To this end, the research proposes the following steps:

– First, it analyses the current literature on the war in Ukraine and explores the main arguments leading to the conclusion that macro-numbers are once again a decisive factor in military conflicts.

– The specific case of China will then be examined to determine the extent to which its mass production capacity, innovation in defence technologies and demographics may have an impact on the Taiwan issue.

1.3 Methodology and limitations

Initially, a literature review of lessons learned or the implications of the war in Ukraine was carried out, using keywords related to the research question and only assessing publications following the Russian invasion of Ukraine in February 2022. For this purpose, online academic search engines were used such as the single academic search engine of the Autonomous University of Madrid (UAM) and specific bibliographic databases accessible from the UAM library, and political science and humanities databases such as Dialnet, Scopus or Web of Science.

Due to the focus of this research, only analyses at a strategic or political level, i.e. macro or statistical levels, and not conclusions on specific operations or tactical combat without wider implications, were accepted. Having identified the main strategic lessons of the war in Ukraine, each of these lessons was explored in greater detail.

This was followed by a literature review and a specific search for data on China with regard to the fields identified above. This is where the research encountered the greatest difficulties, as data on the Chinese military is limited. To remedy these shortcomings as much as possible, searches were repeated, some of the most comprehensive open databases were explored, such as those of the World Bank, the *Stockholm International Peace Research Institute* (SIPRI) or the *World Intellectual Property Organization* (WIPO), and the search was extended to indirect indices that provided information that could be complementary to the focus of the research. Out of these databases, only SIPRI has a section for Taiwan, and therefore, in some cases, the *Ministry of Science and Technology Statistics Database* of the Taiwanese Government was used. The data found were analysed and presented in an orderly and coherent manner.

The graphs included in this article have been generated by the authors, using the data sources indicated in each case. Additionally, in order to facilitate the reading of the text, quotations have been translated by the author in the Spanish version of this document.

1.4 Structure

Section 1 constitutes the introduction. It sets out the background and relevance of the research, then states the hypothesis and the intermediate steps to be taken to test

its validity or falsity, followed by a discussion of the methodology and its limitations, and finally the structure of the article.

Section 2 deals with the lessons of the war in Ukraine. First, the general concept of the return of numbers as a key element of warfare is discussed, followed by a more in-depth treatment of each of the three main factors identified: the mass production of conventional weapons, the capacity for defence technological innovation, and demographics.

Section 3 presents information and data on China for each of the three factors identified in Section 2. This section is the most extensive as it is the focus of this research.

Section 4 presents the conclusions of the research.

2 Lessons from Ukraine

2.1 The return of the mass

Just three months after the Russian invasion of Ukraine in February 2022, a publication in the journal *Global Politics and Strategy* concluded that the Russian army's initial manoeuvre had failed mainly as a result of the following:

> "Russia's military leadership had overdosed on ideas of next-generation warfare, whereby subversion and psychological operations in combination with long-range precision strikes would weaken the enemy so that little conventional force would be needed" (Dalsjö *et al.*, 2022: 13)

Along these lines, a publication by *Foreign Affairs*, entitled *Back in the Trenches: Why New Technology Hasn't Revolutionized Warfare in Ukraine*, highlights how some experts, faced with the advent of artificial intelligence, drones, hypersonic weapons and other advances in military techniques, declared that the Ukrainian War would be "a pivotal moment in military history" or even a new "military revolution", and nonetheless, the course of the war had demonstrated that this was not the case (Biddle, 2023: 153-164).

After the development of various stages of the war in Ukraine, there appears to be one point of agreement in the current literature, namely that the inclusion of the latest technological advances into warfare has not brought about the hoped-for revolution. According to some experts, what is happening is more of an evolution of the modern system that emerged at the end of World War I, modern warfare against an organised enemy will continue to involve a massive consumption of munitions (Bolton, 2023: 1-14; Biddle, 2023: 153-164). Technology has greatly influenced and modified the uses of warfare, but it has not become the sole criterion for victory or defeat, nor is it facilitating a rapid resolution, contrary to what some had hoped, returning instead to consumption and numbers that were thought to have been left behind in the past.

In other words, as stated in a publication of the *Defense & Security Analysis*, "the Ukraine War has reminded the world of the military importance of mass" (Marsh, 2023: 331).

This premise is justified in several ways. One way is to look at statistics on deaths and the use of military equipment in this war. The above-mentioned *Foreign Affairs* article concludes that the high numbers of destroyed assets such as tanks and aircraft are similar to those suffered at different stages of World War II, and the appalling fact that 80-90% of casualties in Ukraine are caused by artillery is in keeping with the fact that since 1914, artillery has been the deadliest weapon in warfare (Biddle, 2023: 153-164).

It is true that the use of precision weapons, in combination with technological advances that enable the seamless transmission of information, has significantly increased the effectiveness of artillery, representing a remarkable evolution in the art of warfare. In fact, the same study demonstrates how the artillery effectiveness ratio in Ukraine has risen to 8 per 100 rounds, compared to 3 per 100 rounds in World War II. Therefore, technological advances in this field, such as surveillance drones, target acquisition systems, automation and information communication, have been very relevant. However, it also highlights how most of the munitions fired by both sides are relatively outdated (Biddle, 2023: 153-164).

Therefore, some of the most relevant technological advances integrated into this war, compared to World War II, such as precision systems and techniques that accompany artillery and which have led to significant innovation, even at the strategic level, are also conditioned by the use of large amounts of conventional ammunition.

Other analyses of the war have come to similar conclusions. For example, it is argued that during the first stage of the fighting, media attention focused on the anti-tank weapons supplied to the Ukrainians by the United States and its allies, such as the Javelin System. In the hands of Ukrainian special units, these technologically advanced weapons achieved considerable successes and forced a change in the usage and movement tactics of some Russian units. However, Javelin-based actions accounted for a small proportion of the fighting that took place. Conversely, during the first stage of the war, Ukrainian artillery, tanks and regular units played a much more important role in the battles around Kiev, Kharkov and other cities (Marsh, 2023: 329-352).

It is also discussed how, at the start of the second stage, Russia had a roughly 12:1 advantage in artillery guns and was firing around 20,000 shells per day, while Ukraine could only fire around 6,000. This superiority is directly related to Russia being able at that time to advance with its forces, after completely destroying the Ukrainian defensive positions (Marsh, 2023: 329-352).

By contrast, the next phase of the war, in which Ukraine managed to fight back and achieve very significant gains on several fronts, is attributed to the shortage of supplies for the Russian forces, which were spread too thin. This was particularly the case in the Kherson region, where the Ukrainians were able to hinder the logistical crossing over the Dnieper River by Russian forces using precision-guided artillery

such as the recently donated US HIMARS rockets. In parallel to the supply shortages on the Russian side, the United States had also transferred of more than half a million artillery shells to the Ukrainian side. The superior use of artillery ammunition by the Ukrainian side was the main cause of attrition of the Russian forces in this phase (Marsh, 2023: 329-352).

The increased battlefield surveillance provided by new technologies makes it more difficult to conceal force concentrations and other preparatory offensive activities from the enemy, which hinders the launching of surprise attacks on unprepared defences and therefore favours defensive manoeuvres and slows the pace of war. It is when a war drags on or stalls that numbers become very relevant.

Unfortunately, this war is not only consuming weapons and ammunition; the human casualties are tragically heavy. The conflict is leading to a large number of deaths and injuries on both sides of the conflict as well as among the civilian population, especially in Ukraine, and has also resulted in a large number of refugees and displaced persons.

A Ukrainian publication emphasised Russia's superiority at the time of the invasion, not only because Russia had more military hardware, but also because it had almost four times more soldiers in its armed forces (Kyzym *et al.*, 2022: 47-57). In fact, according to one US military expert, if the first lesson of the Ukrainian War is the high cost of arms, the second lesson is the critical value of troop training, without which weapons and technology are ineffective (Bolton, 2023: 1-14).

Other US sources claimed in August 2023 that troop losses due to death or disabling injuries in the conflict could be as high as 500,000 between the two sides. Russian losses were estimated to be around 300,000 and Ukrainian losses just under 200,000, however, the greater number of Russian troops, reservists, paramilitary forces and population meant that "troop deaths could have a greater impact for Ukraine" (Cooper *et al.*, 2023).

These high losses, added to the tens of thousands of civilians wounded or killed and the nearly 8 million Ukrainians who have fled the country since the outbreak of hostilities, highlight the demographic dimension as a crucial strategic factor in the war (Pardo de Santayana, 2023).

2.2 Numerical and industrial considerations

The analysis of the literature review on lessons learned from the Ukraine War at the strategic military level identifies three main factors. The mass factor in the use of conventional weaponry, the factor of the evolution of warfare as a result of technological innovations, and the demographic factor. Of course, more relevant factors worthy of attention may be found in the war in Ukraine, especially at the operational or tactical, organisational or doctrinal levels, however, this research limits the scope of its focus for more a more in-depth rather than general approach, as well as to comply with

the size limitations of this article. This research focuses on macro-type factors at the strategic level. This limitation must therefore be taken into account in the conclusions reached by this research.

2.2.1. Factor 1: mass production of conventional armaments

The defence industry, and especially its production capacity, has traditionally been a major factor in warfare. In the case of the Ukrainian War, in which "conventional artillery has fired millions of unguided shells, so many as to strain the production capacity of the industrial bases in Russia and the West" (Biddle, 2023: 153-164), is proving critical.

A study by the *Center for Strategic and International Studies*, which analyses the numbers of military transfers to Ukraine from the US and their replenishment ratio, concludes that most inventories will take years to replenish, and has identified a serious problem in artillery ammunition (Cancian, 2023).

The problem with this type of ammunition may be easily understood if it is noted that the Ukrainian armed forces consumed an average of almost 5,000 155 mm shells daily in 2022, while US production of this type of material amounted to just over 3,000 shells per month (Cancian, 2023). The production figures are expected to increase, but in any case, it is estimated that the war has already consumed six years' worth of production of this ammunition (Biddle, 2023: 153-164).

These data explain why, only one and a half months after the invasion, assessments were already being made such as: "The current level of support to Ukraine is not sustainable for the long term [...] the rate of munitions expenditure in modern warfare far exceeds the current pace of production" (Schaus, 2022).

At the outset of the war, the United States and the European states lacked adequate arms reserves and industrial capacity to sustain a high-intensity war. This is because from the mid-1990s until the war of Ukraine itself, it had been assumed that warfare between the great powers was a thing of the past and that future military operations would focus on terrorism, counter-insurgency or confrontation with militarily weak rogue states, such as Iraq in 1991 (Barnett, 2005).

As a consequence, defence industries adopted efficient production methods, such as those first developed in the commercial vehicle industry, which reduced costs per unit produced, but have also limited the scope for rapid scale-up of production in the event of a crisis (Marsh, 2023: 329-352). Thus, after the first year of the Ukraine War, due to the Russian invasion, it was already clearly identified that the US and its European allies were facing serious production problems (Chávez *et al.*, 2023).

In addition to the fact that defence industries, at least in the West, were not prepared to make drastic increases in production, modern weapons systems have not made it easy either. In general, "because modern weapons require high-tech manufacturing, they take

more time than previous equipment; producing them at scale is difficult, and stockpiles are critical as are the capabilities required to deploy them" (Bolton, 2023: 1-14).

High-tech weapons require complex production chains, for example, the manufacture of the Javelin system involves 16 US states, and the HIMARS system and its GMLRS rockets are manufactured in plants in 141 different locations (Chávez *et al.*, 2023). Each of these plants is a potential bottleneck to increasing production.

The high amount of weaponry required by the Ukrainian authorities has also shown the discrepancies between the European States themselves, and between them and the United States, resulting in at least 154 different weapon systems supplied by European countries and 27 different ones by the US (Bran, 2023: 169-177). The large number of different weapons systems donated to Ukraine creates inefficiencies in its armed forces due to the difficulties of using them and the complexity of the logistics required.

The consumption of arms and ammunition is so high in the war in Ukraine that members of the US administration and Congress were concerned that flows of military materiel to Ukraine might limit supplies to Taiwan (Lubold *et al.*, 2022).

2.2.2 Factor 2: defence technology and innovation capability

The war in Ukraine has also highlighted the importance of mastering new technologies in the military domain and having the ability to innovate in order to adjust to situations.

The increased effectiveness of artillery is most notable due to improvements in artillery accuracy and its use combined with new target acquisition technologies from drones, satellite imagery or signal analysis tools (Bolton, 2023: 1-14). This compendium of innovations has become an indispensable set of technologies and techniques for both sides.

Hypersonic missiles are another example of a new technology with an impact on the war which, for the moment, are only being used by the Russian side. These missiles have hit high-value targets in various parts of Ukrainian territory on many occasions, causing severe damage. With regard to these missiles, official Ukrainian sources have stated that they do not have the capability to shoot them down (Hall and Olearchyk, 2023). However, there are also reports that some have been shot down using the US Patriot air defence systems.

The Chinese military, which possesses such systems but has never tested them in a real conflict scenario, is said to be evaluating their use in Ukraine and analysing the vulnerability of the Patriot system, which currently defends some of Taiwan's most critical targets, such as radars and command posts (Goldstein and Waechter, 2024).

However, as noted above, the more technologically advanced the weaponry, the more costly and complex its production chain, making it difficult to produce in large numbers. These conditions and the large number of weapons used in the war make it

clear, as Ukrainian sources state, that the development of weapons systems and military equipment must be governed by the principle of "cost-effectiveness" (Krakhmalyov *et al.*, 2023: 117-135).

Technological innovation in armaments and its focus on the cost-effectiveness principle has already had a major impact on the war in Ukraine. In armed conflicts of this scale, it is normal to have multiple cycles of technological races of measures and countermeasures. For example, the sophisticated drones employed in the early days of the war were countered primarily with anti-aircraft missiles, which encouraged the deployment of simpler, cheaper and more numerous drones, which in turn have been countered by simpler and cheaper anti-aircraft artillery or even hand-held jammers (Biddle, 2023: 153-164).

The Ukrainian naval drones have been another example that highlights the importance of the adaptability enabled by technological innovation. Despite having an almost non-existent naval force, Ukraine has used these drones to outmanoeuvre one of the world's largest naval powers. These drones, costing an estimated $200,000 per unit, have damaged or destroyed around two dozen Russian warships, up to a third of the Black Sea fleet, including large landing ships and missile carriers worth billions of dollars. These attacks have forced the rest of the Russian navy to withdraw from the Ukrainian coast (Shuster, 2024)

Mastering certain technologies, as well as the ability to innovate and adjust to situations, is proving to be a critical factor in this war. This has been evident despite the fact that the most advanced and destabilising technology is estimated not to have been transferred and employed in the war in Ukraine due to the fact that, as highlighted by some scholars, the nature of the war has been conditioned by fears of escalation (Marsh, 2023: 329-352).

2.2.3 Factor 3: demographics

The demographic factor as a strategic element in warfare is related to the number of trained troops and the size of the population. It can determine the potential for replenishing casualties in the army's ranks, as well as estimate the nation's capacity to withstand these losses.

Demographics have always been linked to national security. Some experts sum it up by stating that, in essence, the importance of the link between demographics and war lies in the relative ability of a given political unit's population to contribute to its defence or to threaten other political units. For this reason, population increases and decreases have always been identified as vital security issues (Palczewska, 2016: 208-226).

The exact number of combatant troop casualties in the war in Ukraine is uncertain, precisely because it is confidential and sensitive information. This explains why there is such disparity between estimates, which for example put Ukrainian casualties in

August 2023 at around 70,000, and the actual data reported by official sources, which stated that in February 2024 they totalled 31,000 (Armstrong, 2024).

Moreover, as discussed above, it is also clear from the war in Ukraine that personnel readiness is essential for an effective use of assets, especially in the case of more complex weaponry (Bolton, 2023: 1-14). Therefore, the number of troops but also the number of reservists, in that they have served in the army before or have participated in some form of compulsory military service, is especially relevant.

3 China's numbers

The three factors that have been identified, from a strategic and macro point of view, as critical to the war in Ukraine, become especially relevant within the context of Chinese aspirations regarding Taiwan and the risk of armed conflict.

However, due to the limitations of this research, mainly because of the lack of transparency of information in this area, the analysis of these factors applied to the case of China has been carried out with the available tools, which sometimes consist of estimates or indirect measures of the factors to be elucidated.

3.1 Mass production of conventional armaments

As stated in a RAND study, "perhaps the single greatest advantage of the Chinese DIB is its sheer scale" (Weinbaum *et al.*, 2022: 24).

It is well known that China, for several decades, has been dubbed the "world's factory", producing about a quarter of global manufacturing and becoming the global leader in 2009. Parallel to this boom, there has also been a considerable development of China's defence industrial base, meaning that not only have production numbers grown, but some of its technology sectors are deemed comparable in quality to those of other top-tier international producers, especially those dubbed as "pockets of excellence" (Office of the Secretary of Defense, 2022).

The growth of China's DIB has advanced in parallel with the development of its defence state-owned enterprises (Qi *et al.*, 2022: 88276-88294), where eight large companies share the lion's share of the market, which will be discussed in more detail below. Over the past ten years, the revenues and assets of most of these large SOEs have grown by more than 150%, a slower pace than that of the Chinese economy as a whole, but fast enough that they now rank among the world's largest defence companies. One of the most significant injections of resources into these companies has been China's defence procurement budget (Weinbaum *et al.*, 2022).

This section will therefore look at data on China's defence budget, with especial focus on military spending, followed by data on China's main state-owned defence companies.

With regard to China's defence spending, it is estimated that the official figures for China's defence budget do not include a wide range of military-related activities, including items such as military technology research and development and even some major arms purchases (Darling, 2019; Funaiole *et al.*, 2021). For this reason, and in order to obtain more complete figures on China's defence spending, which enable comparisons with that of other powers, estimates by the Stockholm International Peace Research Institute (SIPRI) have been used. The SIPRI method attempts to cover, with its limitations, all direct or indirect expenditures that support the functioning of the military (Tian and Su, 2021).

SIPRI's estimate of China's military expenditure is 1.36 times higher than that officially published by the Chinese authorities.

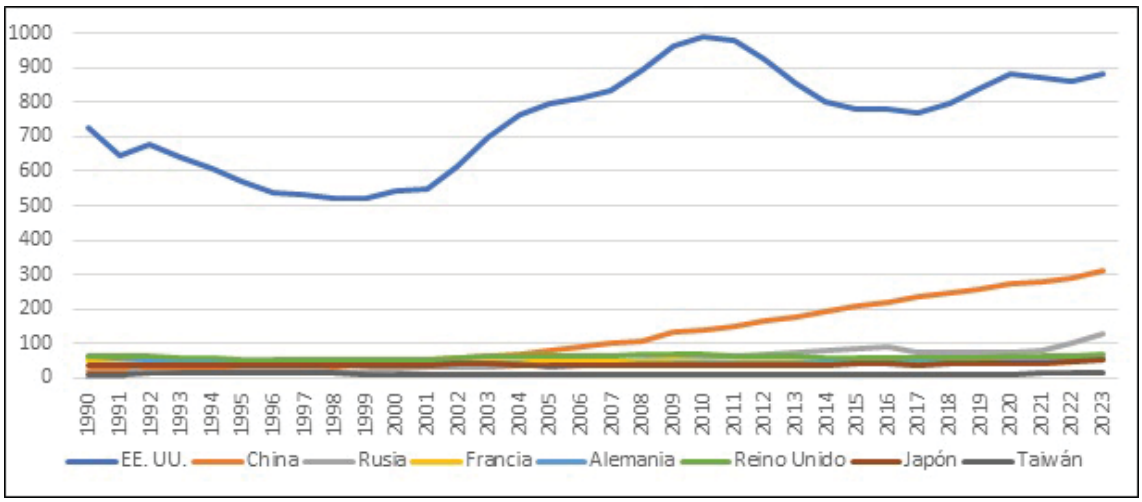

Figure 1. Military expenditure by country (1990-2023) Note: expressed in billions of dollars and based on the 2020 value of the dollar. *Source*: www.sipri.org

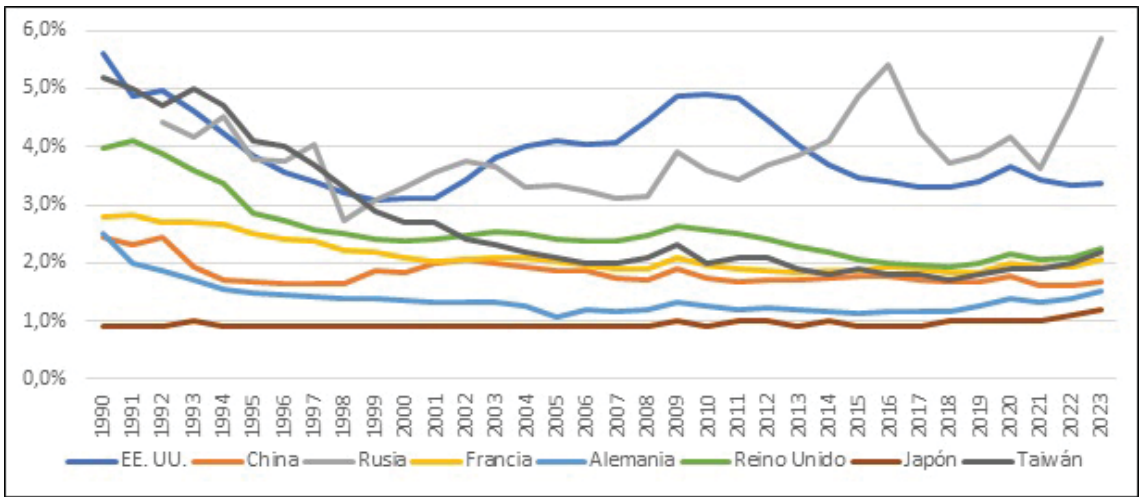

Figure 2. Military expenditure as a percentage of each country's GDP (1990-2023). *Source*: www.sipri.org

Given that these data would not be useful in isolation, but require comparison for their assessment, the figures above display the six countries with the most robust defence industries, according to SIPRI data. They also include Japan, as the world's third largest economy and a growing regional military power, and Taiwan, for the scope of this research.

Looking at both figures simultaneously demonstrates how China has achieved this striking increase in defence spending without increasing the share of defence spending in its budget, keeping it under 2%, well below most defence powers, especially in comparison to the US or Russia. The China's increased defence spending is directly related to the increase in its GDP in recent decades. Moreover, by devoting a medium-low proportion of its budget to defence compared to the other major powers, it may be concluded that China has more room to increase military spending than the other major powers.

The official figures of the Chinese yearly defence budget do not provide insight into how the budget is divided into different items, except for a sample included in the 2019 China Defence White Paper, which shows how the budget has been divided in previous years into three main categories: personnel costs, training and maintenance costs, and equipment costs (Table I).

	Personnel costs		Training and maintenance costs		Equipment costs	
Year	**Yuan**	**%**	**Yuan**	**%**	**Yuan**	**%**
2010	185931	34.9	170047	31.9	177359	33.2
2011	206506	34.3	189943	31.5	206342	34.2
2012	195572	29.2	232994	34.8	240626	36.0
2013	200231	27.0	269971	36.4	270860	36.6
2014	237234	28.6	267982	32.3	323738	39.1
2015	281863	31.0	261538	28.8	365383	40.2
2016	306001	31.3	266994	27.4	403589	41.3
2017	321052	30.8	293350	28.1	428835	41.1

Table I. Official breakdown of China's defence spending (2010-2017) *Note:* in billions of RMB yuan. *Source*: Information Office of the State Council of the People's Republic of China. (2019). *China's National Defence in the New Era*

On the other hand, the 2010 China Defence White Paper lists the elements that, broadly speaking, make up the three main categories of China's defence spending (Table II).

Category	Items
Staff	Salaries, allowances, housing, insurance, food, bedding and clothing for officers, NCOs, soldiers and contracted civilians
Training and maintenance	Troop training, institutional education, construction and maintenance of infrastructure and facilities, and expenditures on consumables
Equipment	R&D, testing, procurement, maintenance, transport and storage of armaments and equipment

Table II. The three main categories of China's official defence budget. *Source*: Information Office of the State Council of the People's Republic of China. (2011). *China's National Defense in 2010*

Therefore, broadly speaking, of these three items, the equipment category represents expenditure on armaments and R&D. Table I shows, in addition to the annual increase in defence spending for all items, that the equipment category is the only one to increase its share of the defence budget, at the expense of the other categories. From 2010 to 2017, the share of equipment spending in China's defence budget grew by almost 8%. This growth is highly significant and, although only 8 consecutive years of data have been published, they are sufficient to show the evolution of the Chinese Armed Forces towards armaments and R&D.

As with GDP, an alternative way to compare defence spending in different countries is through the purchasing power parity (PPP) method. Mark Milley, chairman of the US Joint Chiefs of Staff, claimed in May 2018 that, under the lens of the PPP, and by suppressing personnel costs, China might be spending more on defence than the United States.

After these words by General Milley, the magazine *Breaking Defense* published an article that sought to depict with graphs what the General had stated (Freedberg, 2018). This resulted in the information displayed in the first four columns of Figure 3.

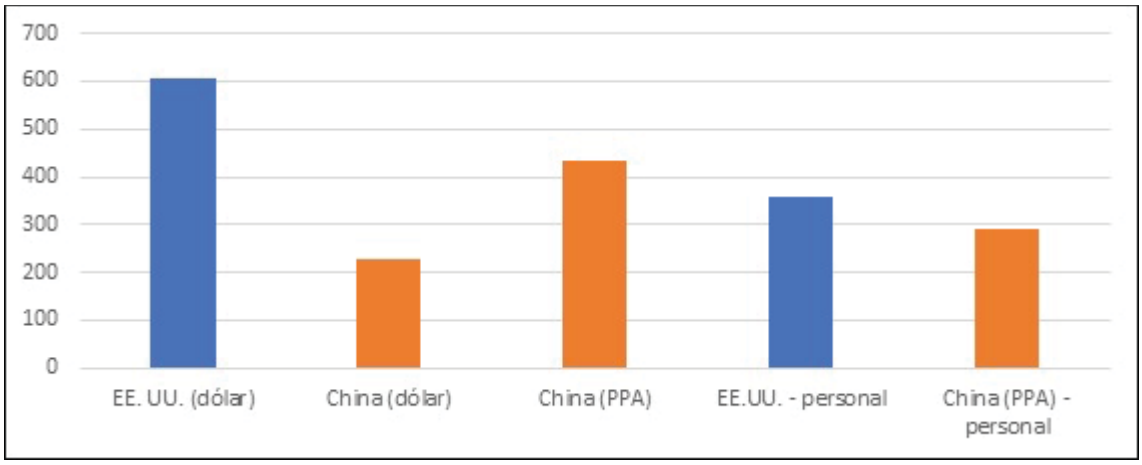

Figure 3. Defense spending in 2017 by China and the United States. Note: expressed in billions of dollars.
Source: www.breakingdefense.com and China's 2019 Defense White Paper

Figure 3 displays, in the first two columns, US and Chinese defence spending in dollars; then, in the third column, a calculation of China's defence spending using the PPP methodology, and finally the US budget with 42% of its total removed as being earmarked for personnel. Additionally, with the knowledge that according to the China Defense White Paper, China spent almost one third of its defence budget on personnel in 2017, a fifth column has been added by the authors, in which the value of China's PPP-adjusted budget is reduced by 33% of its value, which is the approximate proportion of its expenditure on personnel. The ratio of China's defence budget to that of the US using the PPP method is 71%, while the ratio for both is 81% in 2017, according to these estimates.

However, the application of the PPP method according to the common goods and services cost conversion ratio is inaccurate in the case of the defence budget. While the difference in personnel costs between the US and China is high, the difference in the

cost of high-tech goods or internationally traded components such as semiconductors or aircraft turbines is not. Taking into account different PPP ratios according to personnel, training and equipment sectors, the University of Texas estimated that China's total defence budget for 2024 would be around $471 billion. (Fravel *et al.*, 2024: 40-54), which would represent 54% of the U.S. budget, compared to 35% when comparing by the international currency exchange rate, rather than the PPP method.

In any case, what may be confirmed is that China's budget is larger than it appears, that it has increased dramatically in recent decades, and that it is increasingly focused on equipment and R&D, but it is still far from that of the US. However, it should also be noted that China spent about half as much on defence as the United States, according to proportion of GDP, and therefore, if China were to match the United States' defence share of GDP, the two budgets would be very similar.

With regard to the companies that make up China's DIB, since 2001, the magazine *Defense News* has been publishing a list of the top 100 global defence companies. However, Chinese companies did not appear in this list since they did not publicly declare their revenues or provide this information to the organisation. 2019 was the first year in which Chinese companies entered the list as a result of internal estimates made on the top eight Chinese state-owned defence companies.

Figure 4 shows the top 15 defence companies in the world in 2022[1], including six of Chinese origin.

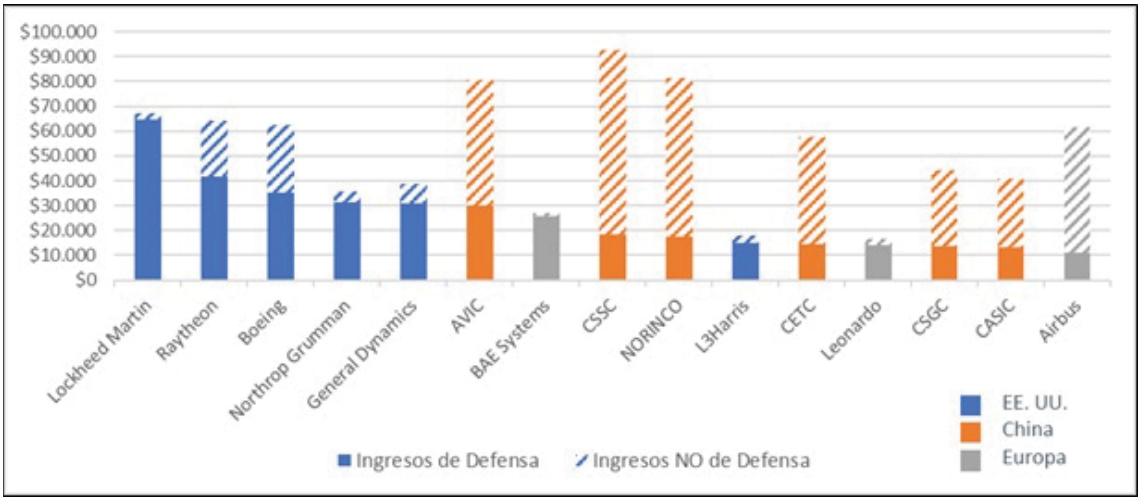

Figure 4. Top 15 defence companies of 2022 by revenue Note: expressed in millions of dollars. Average dollar value for each company's fiscal year. *Source*: Defense News Top 100

When observing Figure 4, it is noticeable that major US defence companies dominate the first half of the table and Chinese companies dominate the second half. It is also noteworthy that Chinese companies have the highest proportion of revenues from the civilian sector, compared to the military. This was a development of Chinese state-owned defence companies as a result of the Defence Industry Conversion policy

1 The 2023 list is not used as only the expenses of four Chinese companies were estimated in said year.

of the 1980s, an industrial policy of dubious efficiency in terms of benefiting the military, but which succeeded in getting these companies involved in civilian products as a means of obtaining higher revenues (Bitzinger, 2021: 5-24). The large-scale involvement of these companies in civil sector products is now a unique feature.

For this reason it is interesting to look at the same data from another perspective, that of the total revenues of each company (Figure 5).

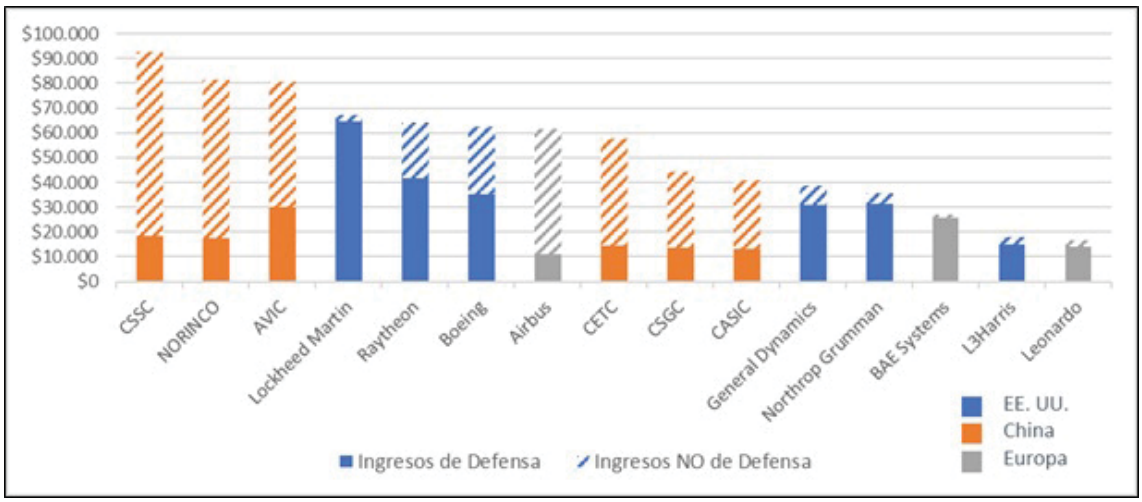

Figure 5. The top 15 companies in 2022 by defence sector revenues, ranked by total revenue. Note: expressed in millions of dollars. *Source*: Defense News Top 100

From this perspective, Chinese companies do not seem to be as dominated by US companies, since Chinese companies have a higher aggregate volume of revenue. For example, Boeing has 16% more defence revenues than AVIC, however AVIC has 29% more total revenue, which begs the question whether Boeing is a bigger defence company in the aerospace sector than AVIC.

Some of the main advantages of this feature for China's defence industry are: greater diversification and economic stability, as it is not subject only to defence contracts that may be more cyclical or subject to political changes; a greater tendency towards civil-military technology transfers; benefits of economies of scale; and greater potential for reconversion and adaptation, for example, by shifting factories from civilian or dual production to military armaments.

On the other hand, the fact that the Chinese defence industry is dominated by state-owned companies is often cited as one of its main weaknesses, due to the fact that these types of companies tend to be associated with greater bureaucracy, fewer incentives for innovation, greater corruption, and increased difficulty in establishing relations and cooperation with international institutions for technology transfers.

It would be of interest to conduct an in-depth analysis of the production of missiles, aircraft, as well as other ground systems and munitions, by China's major state-owned defence companies; however, one of the most prominent areas of Chinese military production is naval production, led by the *China State Shipbuilding Corporation* (CSSC). CSSC is the only primarily naval-focused company that ranks among the

top 15 defence companies in the world, and it is precisely the company with the highest total revenues (Figure 5).

China's naval industry has experienced highly significant growth in recent decades, both in numbers and technology. In the late 1980s, the People's Liberation Army (PLA) Navy consisted of a smaller force with defence capabilities limited to coastal and territorial waters. However, in 2024, the PLA Navy ranks as the second largest in the world by displacement tonnage[2], second only to the United States, and the largest in the world in number of active vessels, with over 370 ships and submarines, compared to 290 in the United States.

This may be explained by the fact that the Chinese fleet does not have as many large ships as the US aircraft carriers, but also by the fact that it is a much more modern and lighter navy than the US, given that around 70% of the Chinese fleet was launched after 2010. Of the US navy, only 25% of the ships meet this condition. It is also worth noting that the US Office of Naval Intelligence estimated the production capacity of Chinese shipyards at around 23 million tons, more than 200 times that of US shipyards, with less than 100,000 tons (Trevithick, 2023).

CSSC, which by 2021 was the world's largest shipping company and by 2024 is expected to account for 41% of global shipbuilding, also has a very interesting feature in that all vessels produced by CSSC are built to military specifications, in accordance with the Chinese Government's doctrine (Brussels, 2024). This indicates that China would have a very high capacity for the military conversion of its naval production.

One should not jump to conclusions, as it is widely accepted that the technological level of the US naval industry, and other defence sectors, is significantly superior to that of China. However, in terms of mass production, China's numbers contrast with the fall in US military naval production capacity since World War II (Bolton, 2023: 1-14)

3.2 Defence technology and innovation capability

It is increasingly common to come across expert analyses or military and technological reports that claim that China is no longer an emerging power in science and technology but is competing with the United States for global primacy (Weinbaum *et al.*, 2022).

An article in the journal *Foreign Affairs*, which concludes that the United States' lead in terms of knowledge and technological power is diminishing, proposes that "firms play an essential role in technological innovation, but the innovation supply chain actually starts earlier, in campus laboratories and classrooms" (Zegart, 2024).

2 The displacement of a vessel refers to its weight.

There is a lot of literature on the factors involved in defence technological innovation systems, but common elements may be found, highlighting certain macro and measurable elements, which are the focus of this research, such as investment in R&D, the number of published patents, articles, citations, ongoing projects or the availability of human talent (Cheung, 2018; Soare and Pothier, 2021).

Due to the limited information available for these factors that are specific to the Chinese military, data on Chinese R&D expenditure, publications in scientific journals, availability of research talent and patents have been used, supplemented with information from the military where possible.

China's macro data show that the considerable growth of its economy in recent decades has been accompanied by its great boom in R&D, as may be seen in the following figures.

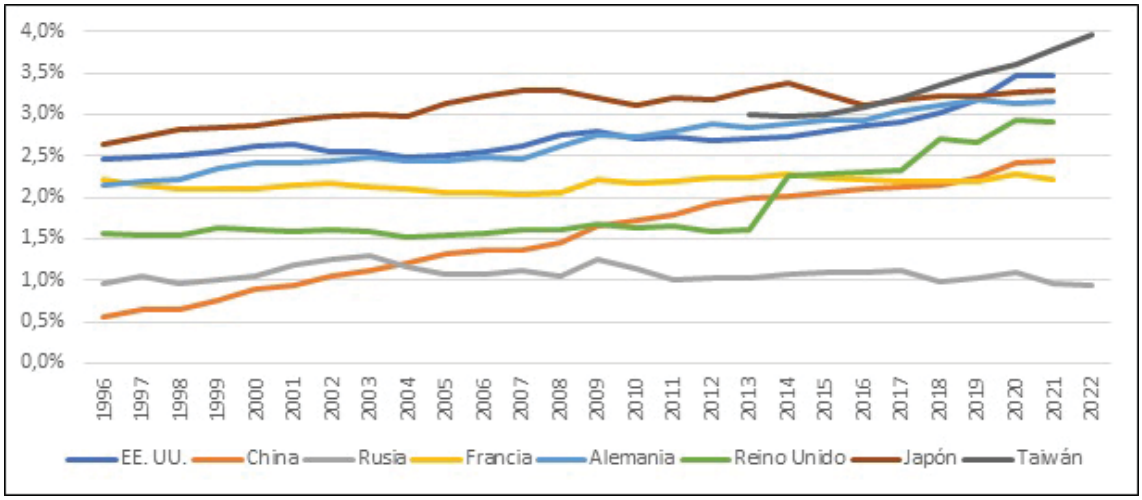

Figure 6. R&D expenditure as a percentage of GDP for each country (1996-2022). Note: no data are available for years earlier or later than those shown. *Source*: https://datos.bancomundial.org/ (except Taiwan: Ministry of Science and Technology Statistics Database)[3]

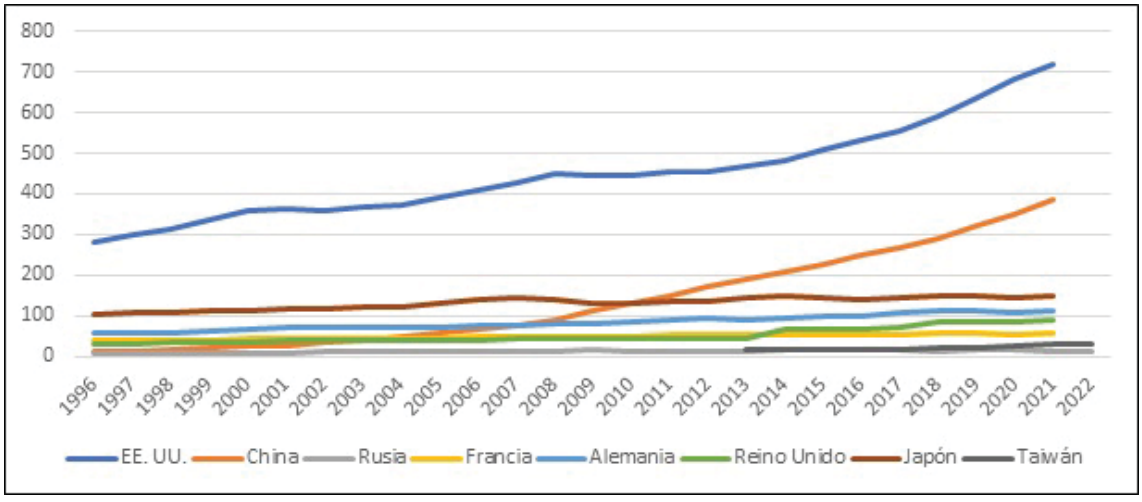

Figure 7. Actual R&D expenditure (1996-2022). Note: expressed in billions of dollars and at constant 2015 dollar values. *Source*: https://datos.bancomundial.org/ (except Taiwan)

3 This is the case for all subsequent graphs with data on Taiwan.

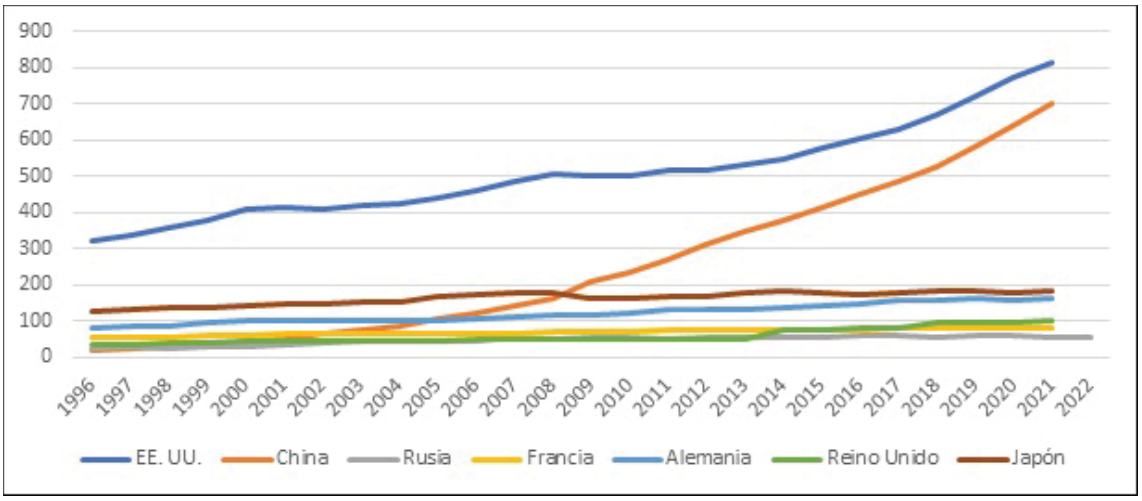

Figure 8. PPP-adjusted R&D expenditure (1996-2022). Note: expressed in billions of dollars and equalised to the dollar per PPP at constant 2017 dollar values.*Source*: https://datos.bancomundial.org/

Figure 6 shows that China has increased the percentage of GDP earmarked for R&D by nearly a factor of five between 1996 and 2021, moving up from a very low position to an intermediate level, somewhat below that of some of the more advanced countries. However, although China does not stand out in terms of the proportion of GDP spent on R&D, its strong economic growth has allowed it to pull away from other powers in terms of actual R&D expenditure (Figure 7) and move closer to the dominant position of the United States.

On a supplementary basis, Figure 8 shows a PPP comparison calculation, according to which China exceeded the combined R&D expenditure of the entire European Union in 2014 and is catching up with the United States, which also appears to accelerate its own spending in recent years in the face of China's intercepting trend. However, it should be noted that as China's economy continues to grow and its wages and costs become closer to those of the major powers, the PPP method of calculation will be less effective in maximising the estimates of investment by the Chinese authorities.

From these observations, it is clear that China's total volume of R&D investment is already comparable to that of the United States, even though it is still far behind in terms of the proportion of GDP earmarked for this area.

In a publication of the Spanish Institute for Strategic Studies (IEEE), Gonzalo León Serrano (2020: 23-76) explains that "the goal of the R&D effort is, obviously, to have the capacity to master the development of emerging technologies" and adds that if this effort is accompanied by boosting the industrial sector and a sufficient availability of human resources with the appropriate training, "it will allow the short term control of the global market via the development of highly advanced products and services based on these emerging technologies".

Thus, in terms of R&D spending, the combination of China's increasing budget and the growth of its economy has had the effect of transforming China from a laggard in the early 1990s to a leader today, on track to dominate future emerging technologies. To complete the analysis of the R&D budget, as indicated by León Serrano, the availability of human resources must be studied.

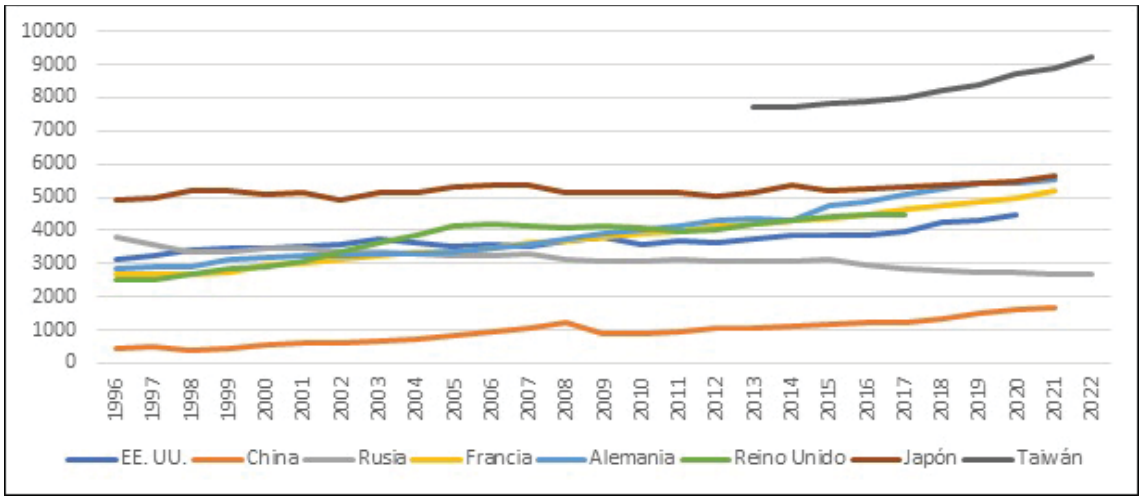

Figure 9. Number of researchers per million inhabitants (1996-2022) Note: no data are available for years earlier or later than those shown. *Source*: https://datos.bancomundial.org/ (except Taiwan)

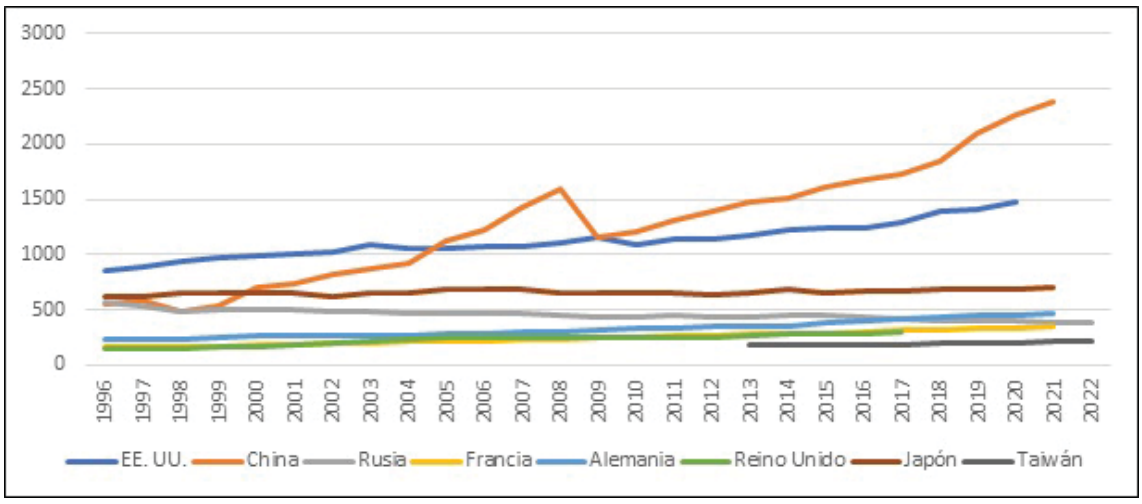

Figure 10. Number of total researchers (1996-2022). Note: expressed in thousands. *Source*: https://datos.bancomundial.org/ (except Taiwan)

In terms of the availability of research personnel per million inhabitants, Figure 9 shows that China is still far behind the major powers, despite a remarkable growth in this regard since 2000. This is partly a reflection of the social inequalities that exist in China, which hinder its human resource potential. However, it is worth examining how its huge demographic base compensates for this limitation and even pushes China to the first position in the world, ahead of the United States, in terms of total number of researchers, as may be seen in Figure 10.

For Chinese researchers Zhang Jihai and Li Bing, as expressed in a study on China's "Collaborative Innovation System in National Defence Science and Technology" for the *Beijing Institute of Technology*, China's human resource in terms of researchers is a weak point of the system. However, it is also a great opportunity, should it succeed, as Zhang and Li state, in "unleashing" its full potential.

Indeed, if China were to have half the number of researchers per million inhabitants as the United States, China would more than double the number of researchers. This is indeed a sign of China's potential and the fact that it is not being tapped.

Additionally, publications and patents are one of the main factors examined in order to comprehend a country's success in terms of its R&D.

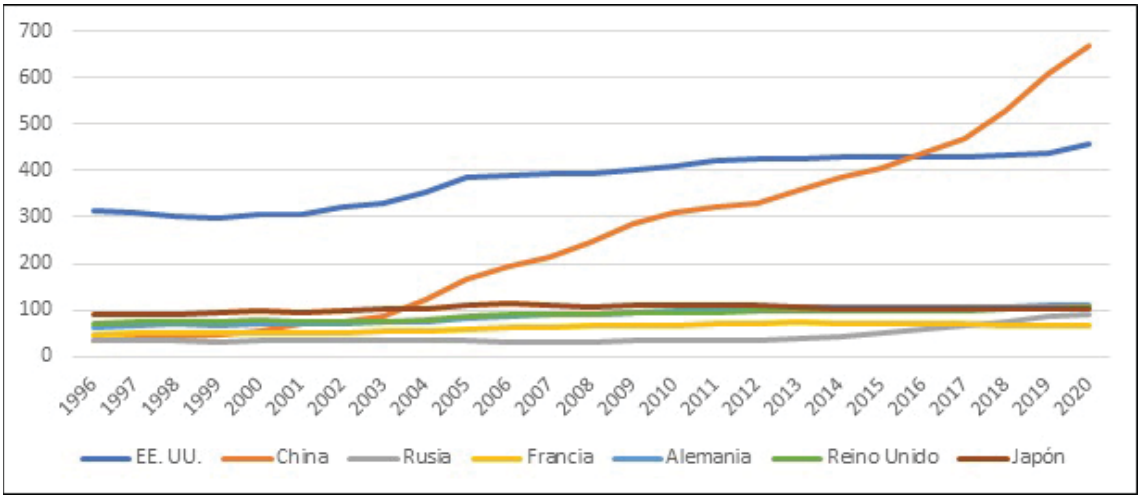

Figure 11. Number of articles in scientific and technical publications (1996-2020). Note: expressed in thousands. No data are available for years earlier or later than those shown. *Source*: https://datos.bancomundial.org/

Figure 11 shows the dramatic increase in the number of articles in scientific and technical publications originating from China in recent decades, making China the leader in this regard.

However, the number of publications does not necessarily mean an equivalent quality of said publications. One of the main means of measuring the quality of publications is by examining how often they are cited, and more specifically, by looking at how many of a country's articles are in the top 1% or 10% of the most cited articles in the world. According to data from Japan's Ministry of Science and Technology (Matsuzoe, 2022), within the period from 2018 to 2020, China was leading in the number of articles ranked in the top 1% and top 10% most cited articles in the world, as can be seen in Figure 12.

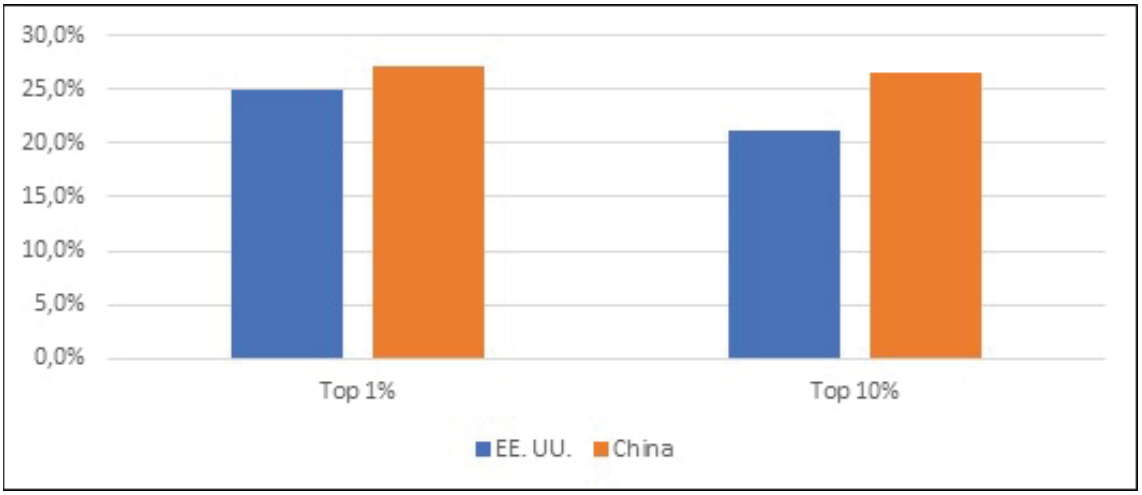

Figure 12. Proportion of articles from the United States and China making up 1% and 10% of the world's most cited articles in the period 2018-2020. *Source*: Matsuzoe, 2022

The large number of Chinese publications in scientific journals, and the predominance of high-quality publication indices, is a very significant demonstration of the results of the country's strong R&D focus.

As far as patents are concerned, the case of China is especially unique. The WIPO data on patent applications and grants for Chinese applicants are extraordinary, with China surpassing the United States in patents granted in 2015 and had three times as many patent applications as the US in 2022.

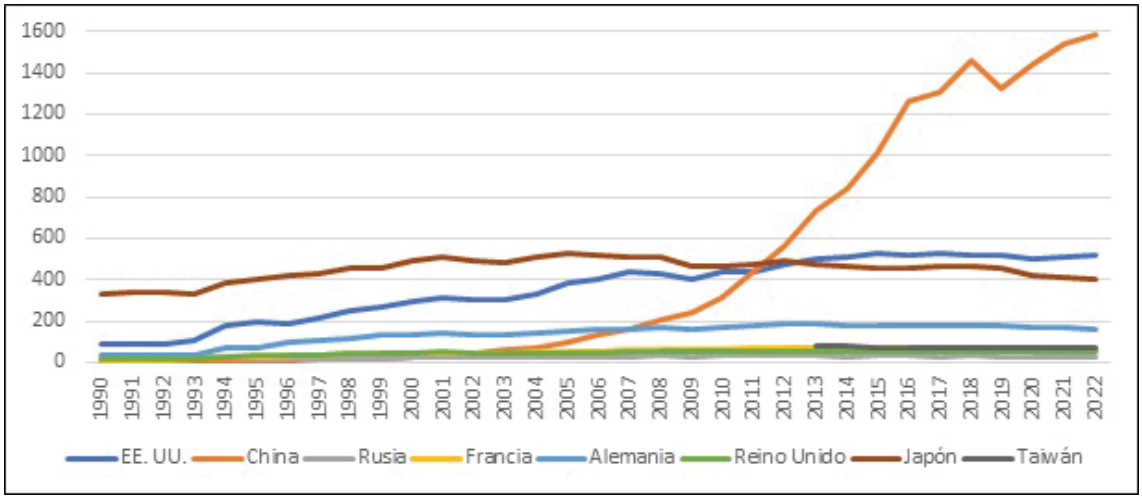

Figure 13. Total patent applications by country of origin of applicants (1990-2022). Note: expressed in thousands. The totals include residents and non-residents of the selected country of origin. *Source*: https://www.wipo.int/ (except Taiwan)

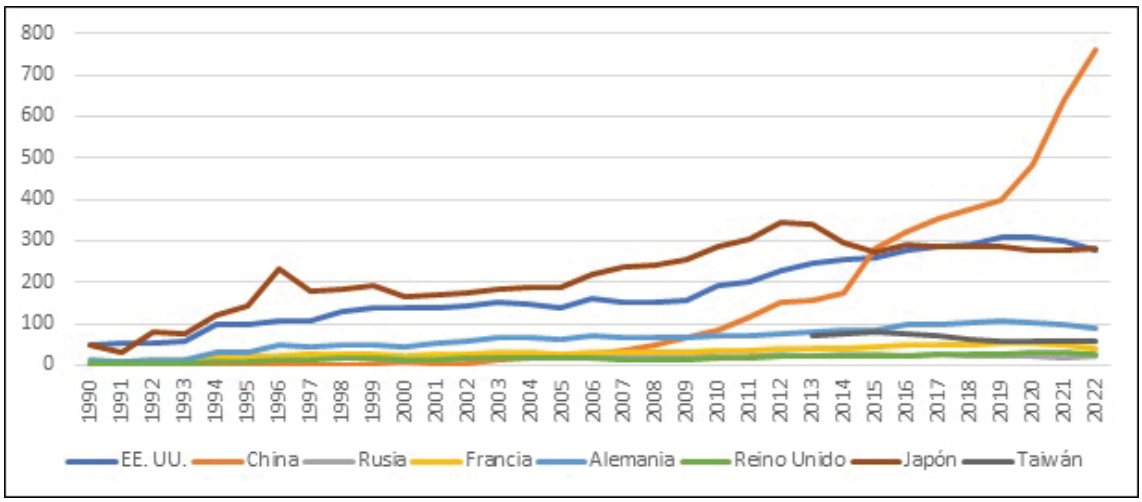

Figure 14. Total patent grants by country of origin of the applicant (1990-2022). Note: expressed in thousands. Source: https://www.wipo.int/ (except Taiwan)

This is truly astonishing data, as China now accounts for more than 45% of all patent applications worldwide.

However, these data are not always read optimistically. For example, according to a study by the Centre for International Governance Innovation (CIGI), these data do not reflect the reality of innovation in China as they claim that rather than being driven by research, the large increase in China's patent applications are mostly driven

by other motives, such as seeking government subsidies, job promotion, building reputation for individuals or universities and institutions, or obtaining certification as domestic high-tech companies (He, 2021).

CIGI insists that quality is the weak point of China's patents and for this they point to certain indicators such as the degree of commercialisation of patents, their internationalisation, or the grant ratio. For example, they point out that China's patent grant rate for 2020 is 33% while that of the US is 61%. Moreover, according to 2019 WIPO data, only 6.3% of Chinese applications were also filed abroad, while 45.3% of US applications were filed abroad.

Due to these arguments, it is worth looking at the evolution of the patent grant rate.

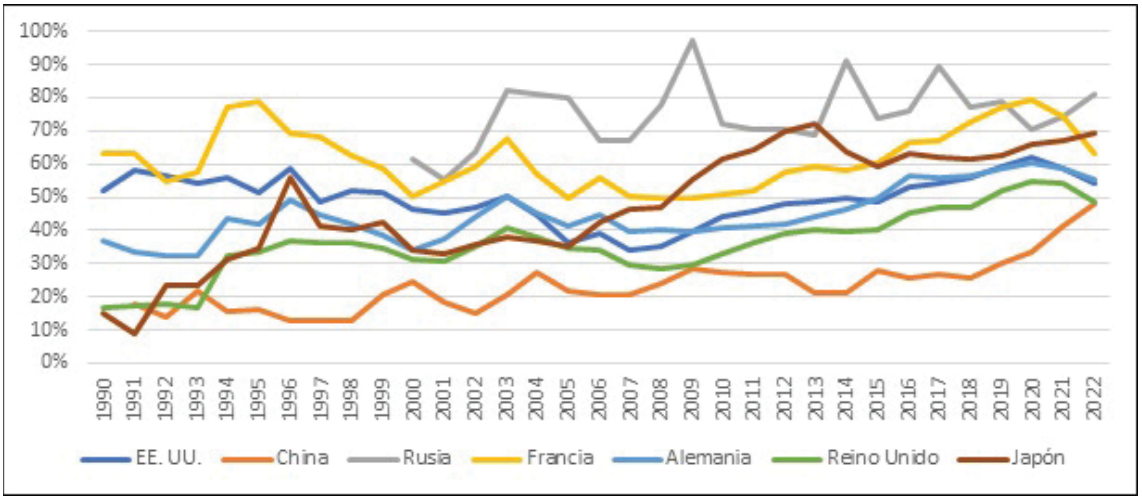

Figure 15. Patent grant rate by country of origin of applicants (1990-2022). *Source*: https://www.wipo.int/

The data displayed in Figure 15 negates, albeit only partly, CIGI's argument since, just two years later, in 2022, the US and Chinese patent grant rates have evolved to 54% and 48% respectively. China's rate has evidently improved considerably in recent years to position itself at levels very similar to those of the UK, Germany and the US.

China does not devote more of its State budget to R&D than its competitors, but its high economic growth is enough to put China at the forefront of the world in this area. This is also the case for the number of researchers in China. While China has almost three times fewer researchers per million inhabitants than its competitors, China's large population means that it still has more researchers than any other country.

These factors have led to much of the increased research activity, reflected in the fact that China is now leading in the number of scientific publications, the proportion of top-cited papers and the number of patent applications and grants.

While it is true that some indicators reveal shortcomings in the quality of certain aspects of R&D in China, despite these weaknesses, there can be no doubt about the extraordinary leap China has made in recent decades and the enormous potential it has to position itself at the forefront of the R&D world.

Nor should any hasty conclusions be drawn from these data. It is not that China has more advanced weapons systems than the United States, which is not generally the case, but that China has developed a strong research base that equips it with future innovation capabilities. This innovation base is also driven by China's large economic and population numbers.

3.3 Demographics

According to World Bank data, China has the second largest population in the world with 1.419 billion inhabitants in July 2024, second only to India as of 2023 and, for the time being, by a few million. However, the agency's projections predict that China's population will start to shrink from 2023 onwards.

The PLA is the largest armed force in the world with 2.3 million active soldiers and some 510,000 reservists. China has compulsory military service, with a general duration of 2 years, but not all Chinese youth are required to participate; instead, volunteers and a small and variable number of randomly selected young men and women participate. Women are also involved, but to a lesser extent and for medical or similar tasks. Every year in China some 13 million boys come of age.

Taiwan has a population of about 24 million, only 1.7% of China's population, and approximately 180,000 males come of age each year. Its army consists of 300,000 active troops but the island has another 2.5 million reservists.

Taiwan's reservist system is robust and has been developed with the eventuality of conflict with China in mind. Military service in Taiwan requires all men over the age of 18 to undergo basic military training, which was extended from 4 months to 1 year in 2024, due to growing fears for their safety. The so-called "porcupine defence" is based precisely on the rapid mobilisation of a large number of these reservists, who are also maintained at a high level of readiness through regular exercises.

However, Taiwan's internal politics are complex and shaped by the island's two main national identities. The efforts by a majority of its population to establish a new nation-State is met with resistance from a significant minority, who favour unification with their homeland of origin (Lin, 2001: 60-83).

There are also negative aspects to China's demographics. Although China has a lower proportion of older adults than the United States, China's population is aging at an exceptionally rapid rate (Tu, Zeng and Liu, 2022: 1159-1163) It is estimated that by 2050, the proportion of Chinese citizens above retirement age will be 39% of the population, and China does not have the infrastructure nor is it ready to bear this economic burden (Weinbaum *et al.*, 2022).

Despite the challenges that China will have to face with regard to its population, from a strategic point of view, China's enormous population, its large army and its potential to expand it further with young individuals has consistently meant that

different simulations of war in Taiwan that have been published, such as that of MIT (Hanlon, 2000: 51-86), or that of the CSIS (Cancian *et al.*, 2023), never consider the lack of troops as a Chinese vulnerability, but they do so in the case of Taiwan. In these simulations, the decisive criterion is usually China's ability, with the effects of its missile, aviation and naval forces, to establish and sustain a ground force landing in Taiwan. Therefore, the focus has been on the quantity and quality of their weapons systems, since their demographic superiority is not in doubt.

4 Conclusions

The war in Ukraine has reminded the world that wars between great powers are a real possibility. Moreover, it has shown that military technological advances alone are not sufficient to bring about a rapid resolution of the war, but that these advances need to be combined with large numbers of conventional weapons and troops.

The world is watching with unease as tensions rise over the issue of Taiwan, the primary and most dangerous potential cause of war between China and the United States. It is inevitable to observe, with the new perspective provided by the war in Ukraine, the situation in the scenario of Taiwan. Although these scenarios display very different characteristics, the latest lessons from the war provide interesting insights into its evolving nature and may influence current perceptions of the forces.

China is a superpower with an immense population base that is of critical strategic importance in the event of a major war, such as a confrontation with a Taiwan backed by allies, primarily the United States.

China does not need to spend a large proportion of its GDP on defence to be considered a match for the US. Its growing economic base means that, despite generally allocating a smaller proportion of its GDP to defence compared to other major powers, its military receives more resources than any other nation except the US. Furthermore, when comparing the defence budgets of China and the United States using the PPP method, it is clear that the PLA's resources regarding equipment and readiness are not that much lower.

China's state-owned defence enterprises, which constitute virtually the country's entire DIB, show great manufacturing potential. Although they are less active in the military sector than their US counterparts, the sheer volume of their civilian production makes Chinese companies larger producers than their US counterparts in the aggregate. Moreover, as has been observed in the case of the Chinese naval company CSSC, these companies, being under strict government control, are already geared towards military conversion, which may be a decisive ability.

In recent decades, China has also made giant strides in building the foundations of a robust national defence technology and innovation system. It has not needed to become more advanced than other powers, nor to spend more resources on R&D relative to its GDP, nor to train more researchers per million inhabitants to achieve

some of the top innovation rankings. It has been enough for China to accompany its economic growth with a development of some basic R&D rankings, sometimes to positions slightly lower than those of the other powers, as in the case of R&D expenditure as a percentage of GDP, to achieve surprising results such as the figures for articles published in research journals or patents.

In addition to these factors, the large PLA, the formidable potential for troop replenishment, and China's huge population, suggest that combat casualties could be borne at a lower cost than in other powers.

In his book, *On War*, the Prussian military strategist Carl von Clausewitz argued that war tends to expand in new and complex ways that are beyond the ability of military or political leaders to foresee, and that leaders must therefore proceed with caution in any military campaign, for failure to do so leads to disaster.

A conflict scenario over Taiwan could have immeasurably destructive consequences and is a scenario of uncertain resolution. If previously the established military, industrial and technological superiority of the US had appeared to discourage any kind of military escalation, the current return to the massive use of means and troops offers a perspective in which China's position gains strength, according to the hypothesis put forward in this study.

Despite the stark strategic, operational and tactical differences between the scenario of the war in Ukraine and the confrontation over Taiwan, it is the shift in the balance of power in China's favour that may prove decisive. This development recommends acting with great caution, avoiding warmongering rhetoric and not relying on the deterrence of US military superiority as the guarantor of the *status quo*.

On the other hand, Spain, especially within the framework of the European Union, must prioritise incentives for the defence industry, joining forces with its allies and promoting the continuous development of its technological and innovation capabilities. In the aftermath of the war in Ukraine, the European Union has redoubled efforts to jointly boost the defence industry and military technology development, as demonstrated by the March 2023 reinforcement of the European Defence Fund (EDF) (European Commission, 2024a) or in the First European Defence Industrial Strategy of March 2024 (European Commission, 2024b), among other initiatives. These instruments and others working in this direction will be essential to ensure that its armed forces do not present vulnerabilities and maintain pace with the evolution of the art of war, in order to remain effective.

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