China's Race to Rise and Shine in High Technology

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Abstract: This article looks at the nowadays heated competition for technological supremacy between China, a rising technological power, and the US, the current global authority in high technology and grand creator of new industries, innovative products, processes and services. It mainly addresses China's race to not only catch up, but replace the current global leaders in research, development and innovation, in a huge national push to break the technological dependency on the US and on the other technologically advanced nations and, making use of all the available means, legitimate or not, to accelerate the nation's progress towards self-reliance, self-sufficiency, the innovation-driven economy and to the final goal of reaching global technological dominance.

Key-Words: China, high technology, research and development, innovation, RDI, technological competition
JEL Classification: O3, O33, O34

1 Introduction

Following decades of rampant advancement of globalization, in the early 2020s the world is more integrated than ever in its history. Structured in global value chains (GVCs) and international industrial networks, global production involves most countries of the world in various cooperation and trading activities, capitalizing on their competitive advantages and improving every aspect of the economic performance: production costs, input consumptions, the product quality, content in knowledge, innovation and professional skills, the diversity of the offer and its adequacy to the different segments of the world demand. In search of ways to improve economic efficiency and get higher profits, multinational companies (MNCs) constructed this global production architecture by transferring activities between countries, most often from the developed to the developing ones. They first relocated production capacities, transferred basic technologies, lower-skilled jobs, best practice, but in time they came to transfer increasingly more sophisticated technology, knowledge and know-how, higher-skilled jobs, research-development-and-innovation (RDI) capabilities and even intellectual property (IP). Entire industries were gradually relocated between countries, leading to utterly transformed national economic structures and multiple new trade flows among them.

Against this background, international cooperation and global exchanges of goods – primarily of intermediaries – escalated, the MNCs made huge profits, while consumers all over the world got access to a diversity of higher quality goods that used to be unaffordable. As new links of the GVCs, many developing countries benefitted from increased foreign direct investments (FDI) that helped them develop new industries, adopt new technologies, train local labour, educate the young, nurture local innovation and research activities, increase their exports and gross domestic product (GDP). Everyone seemed to be winning, but the true big winners of globalization have been some of the developing countries which understood and used the chance they had to make a significant leap in their development. Among them, the greatest winner of all was China.

China was the developing country that benefitted the most from globalization, foreign direct investments inflows and free international markets to hasten its own economic development, modernization, urbanization and technological catching-up. Within the global production system, as part of a large number of regional and global value chains (VCs), China came to play the central role of *a world workshop*, which assembled or manufactured and exported huge and growing quantities of goods, in most of the goods categories. Consequently, in 2010 it became both the world's largest industrial producer and the top exporter of goods, globally. In some production areas China became the undisputed dominant manufacturer, as for instance in *personal computers*, by making 90% of the global production, or in *mobile handsets* (90%), *air conditioners* (80%), *photo voltaic panels* (70%), *footwear* (65%) and many other industries. In terms of international trade, China came to rank first in the global

exports of over 450 categories of goods, to rank second in other almost 150 categories and third in 100 more others. Among these, it came to make, for instance, 60% of the world exports of *lighting appliances*, over 40% of the global exports of *mobile and landline phones*, as well as 45% of the world exports of *computers* and 35% of the overall exports of other *office equipment* (Rajanayagam, 2020). On the other hand, in other markets – such as for instance in the oil, coal, copper, rice, soy, semiconductors and many others – China is the largest importer globally. It ranks first in the global imports of 200 categories of goods, second in the imports of other about 120 categories and third in 100 more ones. With such a pervasive and highly ranked presence, either as a major exporter, or as a key importer in the international exchanges of goods, this country has become the main trade partner of over 120 countries and has come to play a decisive role in the price formation on many of the world's markets (Pencea, 2020).

Due to consistently high levels of national and foreign investments, to the expanding production and exports, the Chinese GDP kept growing at a high pace for decades and, as such, China climbed into the second position in the global hierarchy of the largest economies, just behind the US. The country got through the 2008-2010 global economic crisis like a winner and, a decade later, it was one of the very few economies that succeeded to avoid recession in the difficult year of 2020, managing, when all the world was devastated by the Covid-19 pandemic, a 2.3% increase in its gross domestic product. Chinese GDP reached USD 14.7 trillion, accounting for about 20% of the world total (Statista, 2020a, b; Capri, 2020a; Kemp, 2019).

However, China's catching-up race did not finish yet – neither once it became the second largest economy in the world, nor after heaping numberless superlatives and top rankings all along this race –, because China is indeed a large economy, but it is plagued by huge debts (300% of its GDP), non-performing loans, overcapacities, inefficiencies, wastage, low and decreasing productivity; it is still unsustainable, uncoordinated and unbalanced[1], still polluted and polluting, still technologically dependent on the West and not able enough to produce original high-tech breakthroughs (West, 2021). The USD 10,000 average GDP per head is still placing China in the dangerous range of the *middle-income trap* risk that occurs when an economy gets stuck in a stage in which it is already too developed to keep building upon low-cost competitiveness and low-tech industries, yet not developed enough to compete in high-tech, knowledge-intensive and innovative activities. It therefore needs to change its growth engines and development model.

Mindful of the *middle-income trap* threat, the Chinese strategists and leadership have long devised and since the early 2010s have also started to implement a number of initiatives, strategies and policies meant to steer the economy to a consumption-led development model, backed by a high-technology, innovation-led economic structure able to confer China, in time, the statute of unique globally-dominant technological power it dreams of. Moreover, the lessons of the 2008-2010 global economic crisis and the disruptions, crises and international tensions triggered by the Covid-19 pandemic, have convinced Chinese decision-makers once more that China's future prosperity and security depended on detaining complete domestic value chains in high-tech industries and a robust knowledge-based, innovation-led economy, capable of generating its own breakthroughs and to pioneer new high-tech industries.

Noteworthy, the *Chinese dream* of recapturing the country's long-lost glory doesn't simply envisage leveling the technological gap that still separates China from the advanced economies and attaining high technological prowess. It rather goes much further, targeting - on the one hand -, the replacement of the current technologically-savvy global powers at the top of the world high-tech hierarchies (US, EU, Japan and a few others) transforming them into China-dependent economies, and - on the other hand -, it aims at changing the global rules, institutions and governance in accordance with China's authoritative socialist system and with its economic and political interests. To that end and to hasten the process, besides strongly supporting the national research, development and innovation effort, the Chinese strategies and policies strive for massively transferring to China, by any means necessary, the latest scientific breakthroughs, any advancements in knowledge, technologies, know-how and intellectual property created in the rest of the world, hoping that once all those are "introduced, digested, absorbed, re-innovated"(Guo, 2005), China could make the leap to truly substantial homegrown innovation, an innovation-intensive, innovation-led economy and, eventually, establish itself as the only leading high tech power of the world. Obviously, the targets of first choice for knowledge and high technology transfers are the US, the EU (primarily Germany, France, Italy, Sweden), the UK, Japan, Singapore,

[1] In the early 2007, Wen Jiabao, Chinese premier at the time, famously labeled Chinese economy as "unstable, unbalanced, uncoordinated and unsustainable". Ten year later, Beijing policies seem to have been quite unsuccessful in completely correcting these issues (Holland, 2017).

South Korea, Taiwan etc., but actually no country may consider itself exempted, especially as national databases are also assets of great interest.

2 A brief account on Chinese endeavour to foster home-grown RDI

Although China had aspired much earlier, since the 1980s, to become a global innovation powerhouse, it was only at the beginning of the 21st century that high-level decisions to back that endeavour were made and proper funding was provided. In the early 2000s Chinese policy-makers started devising increasingly more ambitious industrial strategies and plans that targeted domestic RDI advancement. The ideas and plans produced by a very fragmented science, technology and innovation (STI) system have been gradually refined and agglutinated into a number of unifying landmark documents that provided the necessary strategic vision and guidance. The most important of them are:

- *National Medium and Long-Term Program for the Development of Science and Technology* (2006-2020), (MLP, launched in 2006);
- *A Thousand Talents Plan* (TTP, 2008);
- *Made in China 2025* (MC2025, 2015);
- *Internet Plus* (2015)*;*
- *One Belt, One Road* (OBOR, 2015) renamed *Belt and Road Initiative* (BRI, 2017);
- *A New Generation of Artificial Intelligence Development Plan* (2017);
- *China Standards 2035* (2020);
- *Five-Year Plans* (FYPs), especially the 13th (2016-2020) and the 14th (2021-2025).

Together, these inter-connected, complementary and synergic strategies and plans create a complex, multi-faceted and multi-layered master plan that (i) helps direct the nation's material, financial and creative resources towards a number of attentively selected, high-tech industries of the future (MLP; MC2025), (ii) steer the digital transformation of the economy and support the wide usage of internet applications in every realm of productive activity (Internet Plus), (iii) design the incentives that attract top professionals and talents, Chinese and foreign, to work and innovate in China (TTP), (iv) so that China becomes an absolute RDI and high-tech authority that sets its own technical standards globally (China Standards 2035). On top of all these, BRI is the overarching strategy that is expected to simultaneously meet a whole lot of challenges pertaining to both keenly needed domestic reforms and to a host of Chinese foreign policy goals.

In terms of research, innovation, new technology absorption and development inside China, MLP and its improved continuation, MC2025, make up the corner stone strategies. Nevertheless, while MLP is laying a strong stress on fostering *indigenous innovation* and home-grown technologies, MC2025 is less limitative and isolationist, building more upon the strengths of international cooperation, foreign strategies, best practices and technological accomplishments and moving the accent from domestic to foreign-grown innovation. Given the urgency of meeting the CCP[2]'s ambitious targets before some of the country's most important anniversary events – MC2025 is implying, somehow, that any kind of technology transfers, including the illegitimate ones, are justified, accepted and encouraged, as long as they contribute to building the innovation-led economy and society sooner.

China's spending on research and development (R&D) as a percentage of its GDP has kept increasing even before these programmatic documents were launched, but it substantially accelerated afterwards. As the Chinese annual GDP grew at increasingly higher speed (by an average of about 10% yearly, for over three decades, before the 2008-2010 global economic crisis), the quantum allocated to R&D has escalated too: from just 0.56% of GDP in 1996, R&D expenditures more than doubled in the next decade, to 1.37% in 2006, and then stepped up to 2.12% in 2016, 2.23% in 2019 and 2.40% in 2020. However, in spite of all efforts, it still remained under the 2.5% target set by the MLP for 2020 and way behind the 2.8% accomplished yearly between 2017and 2020 by the US, relative to a considerably larger GDP. Chinese research and development expenditures might reach that same level - 2.8% of GDP -, only by 2025, according to the Center for US-China Relations at the Tsinghua University (World Bank, 2021; Hankock & Zhou, 2021). In absolute value, Chinese R&D expenditures jumped from a total amount of USD 327.8 billion in 2019 (when US spent USD 583.5 billion), to a record USD 378 billion (RMB 2.44 trillion) in 2020, performing a 15.3% (10.3% in RMB) rise in the wake of the US-China high-tech war flare-up and the consequent Chinese renewed push for technological self-reliance and self-sufficiency.

[2] Chinese Communist Party.

China has always chosen to invest very low amounts in basic research, but under the new circumstances that is going to change. The minister of Science and Technology declared in March 2021 that *"During the 13th FYP period the central government's investment in science and technology increased by 70% and the investment in basic research doubled, exceeding for the first time 6% of the total RDI spending in 2019"*. It is estimated that basic research spending reached 6.16% in 2020. Moreover, according to prime minister Li Keqiang's Annual Report and to the documents of the 14th FYP (2021-2025), in the coming five years the country will strive for above 7% annual growth in RDI spending and a raise of basic research expenditures to 8% of the total research and development funding. To accelerate basic research growth and development, in 2021 the central government expenditures will get boosted by 10.6%, according to premier Li. However, considering the force of the American competition and their technological strength, some Chinese experts consider the 8% target still insufficient[3] (Global Time, 2021).

In the 2021 Agenda – which is part of the Government's 2021 Work Report –, two issues stand out more specifically stressed upon: China's urge to climb up the technological ladder and its focus on self-reliance in key technologies development. These two challenges have become once again top priorities for Chinese economy, as they used to be in the MLP. To facilitate success, larger funding will be accompanied by a number of R&D system reforms: research institutes will have more say about funds allocation, researchers will be relieved from undue burdens so that they only focus on scientific activities and their incomes will become really high by introducing flexible tax mechanisms. Researchers will be able to take sabbaticals of up to 6 years to join manufacturing activities or to set up start-ups, continuing to receive their salary and other benefits, having the output obtained in the meantime recognized as academic work and taken into account for personal evaluation and promotions. Research itself will be channelled to sophisticated areas such as: brain science, artificial intelligence, quantum information, genomics, clinical medicine, deep space and deep-sea exploration etc., in order to create a "*strategic research force for the nation"*. Additionally, China will place less emphasis on researchers publishing a great number of scientific papers, shifting interest to evaluations on the basis of their work's impact (Mallapaty, 2021). The blueprint detailed in the governmental Report is expected to determine a big step forward in the volume and structure of R&D spending, a reinforced focus on core technologies in key industries and on finding solutions to the current bottlenecks in the supply of certain American-made or designed inputs (especially semiconductors), leading as such to a narrowing of the still substantial technological gap between China and the US.

3 Chasing technology transfers at all costs

The US-China trade war that started in 2018 and the Covid-19 pandemic declared in 2020 uncovered the deep vulnerabilities that both the US and the Western countries on the one hand, and China on the other hand, suffer from in a tightly integrated global world where the actors are very different in terms of values, political views, economic models, structures, levels of development, national interests and goals and, especially in challenging times such as these, inclined to distrust each other, dislike the dependency of one another and fight with one another for the supremacy they think they need in order to inflict on the rest of the world their own rules, values, model of governance and ways of functioning as communities. Against this backdrop, while China saw clearer and understood better the dimensions and the risks of its vital dependency on the American and, more generally, on the Western technology, the United States and the other developed economies also discovered the magnitude and the perils of having transferred too much of their own productive and innovative activities, their knowledge, know-how and technology, to China. Consequently, all these actors are at present trying some degree of decoupling from the others; all of them are attempting to limit and counter the others' actions while also trying to boost their own high technology capabilities, some of them even at all costs (mainly China, but certainly others too).

3.1 When foreign multinationals accept 'forced technology transfers'…

China is already a country with significant technological capabilities, most of them obtained through the channel of foreign investment inflows and industrial capacity relocations, against the larger backdrop of the industrial policy and of the investment-and-export-driven development model devised by the Chinese state. While high domestic investments and the industrial policy of traditional type – including subventions, cheap financing and inputs, tax exemptions, currency manipulation, protected markets, infant industry and national champions regimes etc. – did play a crucial role in the country's industrialization and modernization, it was the

[3] While in 2019 the US invested USD 105 billion in basic research, China invested just USD 19.7 billion (Global Time, 2021).

technology transfers by the foreign MNCs and especially their errors of judgment in deciding on their business model for the Chinese market that have been decisive for China's success in its swift technological advancement.

Eager to enter the Chinese market and make big profits, more and more foreign MNCs accepted the technology transfers to which the Chinese legislation forced them: they agreed to set up the compulsory joint-ventures with Chinese partners stipulated by the local laws and accepted to license their core technology to those partners, as laws demanded. At the time, the local partners were quite small, apparently harmless firms, too technologically backward to pose any threat to the big Western multinationals, while the technologies transferred were not the most recent ones available. Soon the receipts from the licensed technology would rise year by year to increasingly higher levels and foreign MNCs would cash huge amounts of money which they used to develop other new, more sophisticate and innovative technologies. That seemed a very profitable and well-functioning business model, which brought huge profits and helped foreign companies progress, expand and thrive. Moreover, it was self-feeding and it seemed to be able to continue functioning like that ceaselessly (Capri, 2020a).

In that stage, American giant companies such as *Lucent Technologies* and *AT&T*, or European ones such as *Alcatel* unleashed a trend of information and telecommunications technology (ITC) transfers to the Chinese nascent manufacturers and, as the gains from licensing were enormous, MNCs in the entire high tech sector followed, adopting predominantly the same business model. According to the US Department of Trade, between 2009 - 2019 the American technology companies earned USD 65 billion from the licensing taxes of their intellectual property rights (IPRs), but that amount is considered largely undervalued (Capri, 2020b).

Gradually, as GVCs have naturally found the most profitable locations of their component links, more and more production capacities have been relocated from the US and other OECD countries to China, especially after China's WTO accession. In less than two decades almost all the US production capacity and capabilities in ITC, as well as the IPRs over technologies and products have been transferred to China and today, Silicon Valley innovations can be put in production only in China. In the recent two decades the US lost to China not only millions of jobs, but also much of the knowledge to manufacture.

What happened can be summarized in two short sentences: 1. Chinese laws were intelligently designed, to the benefit of the local industry. 2. Foreign MNCs have been greedy and reckless. In other words, blinded by the market access premium and by the huge receipts they could get from IP licensing, foreign licensor companies unwisely overruled the liberties that the Chinese laws had given to the local licensees. The first one was that they could not be stopped by the foreign IP owner to make changes to the licensed technology or product. Second, in case a Chinese licensee brought any improvement or small change to the licensed technology or product, he could legally register the "new" patent in his name and become the new IP owner of the whole technology or product, no matter how insignificant or minimal the changes made by him had been. Finally, the ownership over the IP was in this way legally transferred to the Chinese company and, according to Chinese legislation, the foreign company had no possibility of recourse in court in order to regain its IP rights. They were simply lost (Capri, 2020a,b).

Forced technology transfers have been at the heart of the US-China trade war started by the Trump administration in 2018, when the US has openly accused China of theft of American intellectual property. Forced transfers have also been present and escalating in China's relationship with the EU companies. According to a survey by the European Chamber of Commerce in China (ECCC), the number of respondent companies that recognized that they had been forced to transfer technology has doubled in only two years reaching 20% in 2019 vs. 2017. It has come out that the pressure to hand over their technology and sensitive information was more intense in the case of cutting-edge technologies: 30% of the respondents to the survey that had been active in the chemicals and petroleum industries, 28% of those in the medical devices companies, 27% in pharmaceuticals and 21% in the auto industries reported compelled tech transfers. Those practices breach the WTO rules and they also violate both the Chinese FDI law stipulation that no administrative measures could be taken to force technology transfers, and China's State Council Document 19, which is forbidding governmental officials to force such transfers (Martina, 2019; Lappin, 2019; Wernau, 2019). On the other hand, besides compelled high-tech transfers, some EU companies chose to voluntary transfer technology and know-how to the local Chinese firms, in order to improve the quality of the products delivered by local suppliers and make them more reliable.

3.2 … and when China transfers foreign technology in aggressive ways

Despite all the progress, Chinese firms still operate far from the frontier of innovation in most industries. Obviously, that is not compliant with the targets set by the country's political leadership, which have planned that China becomes the equal of the big industrial powers of the world by 2025 and then the leading industrial manufacturer and technological force globally, by 2050 (MC2025). As such, the country is under the pressure to meet those deadlines, a pressure that keeps increasing due to the drastic switch - from engagement to suspicion,

disapproval and even to decoupling attempts - in the Western countries' attitudes to China. The reason of that switch rests in China's perpetual way of bending or breaching both the international rules and its own promises and commitments, to the disadvantage of the other countries. Also, it is the comprehension of the reality that China will never become a Western-style liberal democracy, but on the contrary, it will develop and strengthen its own, rival system, dangerous to the West. According to the US-China Economic and Security Commission's 2017 Annual Report "*The Chinese government is implementing a comprehensive, long-term industrial strategy to ensure its global dominance… Beijing's ultimate goal is for domestic companies to replace foreign companies as designers and manufacturers of key technologies and products, first at home, then abroad."* The White House Office of Trade and Manufacturing Policy (OTMP) Report of June 2018, titled "*How China's economic aggression threatens the technologies and intellectual property of the United States and the World"*, severely qualifies China's global actions as *economic aggression* that threatens not only the US economy, but the global economy as a whole, and identifies six categories of the aggression types by their main goals (OTMP, 2018):

- Protection of China's home market from imports and competition;
- Expansion of China's share of the global markets;
- Securing and controlling core natural resources, globally;
- Domination of traditional manufacturing industries;
- Acquiring the key technologies and intellectual property from other countries;
- Capturing the emerging high-technology industries that will drive future economic growth and advancements in the defence industry.

The OTMP Report focuses on the last two categories of economic aggression - that are pertaining to foreign technology and IPRs appropriation -, documenting the ways and methods used by Chinese state-supported companies with a view to getting access to, and ownership of foreign cutting-edge technologies, in considerably easier, cheaper and faster ways than toiling to create them themselves, as summarized hereunder (Table 1). One way or another, these are all forms of economic aggression to the targeted victims, companies that spent time and money, took high risks innovating and could not capitalize on their efforts because they have been stripped off their intellectual property rights and sometimes even pushed out of the markets, in unfair competition with the rivals that have come to own their former IP.

Table 1: Vectors of China's economic aggression in the technology and IP space

1. Physical theft and cyber-enabled theft of technologies and IP	• Physical theft of technologies and IP through economic espionage; • Cyber-enabled espionage and theft; • Evasion of US export control laws; • Counterfeiting and piracy; • Reverse engineering;
2, Coercive and intrusive regulatory gambits	• Foreign ownership restrictions (in China); • Adverse administrative approvals and licensing requirements; • Discriminatory patent or other IPRs restrictions • Security reviews that force technology and IP transfers; • Secure and controllable technology standards; • Data localization mandates; • Burdensome and intrusive testing; • Discriminatory catalogues and lists; • Government procurement restrictions; • Indigenous technology standards that deviate from international norms; • Forced research and development; • Antimonopoly law extrusion; • Expert review panels that force disclosure of proprietary information; • CCP members in corporate governance; • Placement of Chinese employees in foreign joint-ventures;
3. Economic coercion	• Export restraints that restrict access to raw materials • Monopsony purchasing power,
4. Information harvesting	• Open source collection of science and technology information; • Chinese nationals in US as non-traditional information collectors; • Recruitment of science, technology, business and finance talent.

5. State-sponsored, technology-seeking investment	• Chinese state actors involved in technology-seeking FDI; • Chinese investment vehicles used to acquire and transfer US technologies and IP o Mergers and acquisitions o Greenfield investments o Seed and venture funding

Source: The White House Office of Trade and Manufacturing Policy Report (OTMP, 2018).

Each of these forms of accessing significant foreign information, technology or IPRs can be substantiated in detail and completed with examples, but we will include here just a few relevant data and examples regarding some of the vectors listed above.

For instance, in terms of ***Chinese cyber espionage and theft,*** according to recent declarations by the FBI director Christopher Wray, the US people are victims of Chinese theft that amounts *"…to a scale so massive that it represents one of the largest transfers of wealth in human history."* "*We've now reached* a *point where FBI is opening a counterintelligence case almost every 10 hours. Of the nearly 5000 active cases currently underway in the country, almost half are related to China." "…over the past decade, we've seen economic espionage cases with a link to China increase by approximately 1,300 percent."* (Wray, 2020). In the US case, the costs of trade secrets theft alone is estimated to be in the range of USD 180 billion - USD 540 billion annually, the equivalent of 1%-3% of the American GDP (OTMP, 2018). For Europe, a 2018 PricewaterhouseCoopers (PwC) study found out that of all the cyber-attacks, 94% had been in the category of industrial espionage and cyber theft of trade secrets. The most affected country was Germany where 17% of the companies reported sensitive-data theft between 2015-2017; in the UK cyber-attacks were on the rise, with a focus on the financial sector, while in Italy cyber espionage targeted mainly the luxury sector and in Spain it envisaged ITC, defense, chemicals and healthcare industries. According to the European Institute for Security Studies, cyber theft has increasingly affected European academia and research institutes. Cyber espionage is costing Europe EUR 60 billion in economic growth yearly and the trend is upward. Most of the European reports mention Beijing as the most active government in the world in terms of cyber espionage. (PwC, 2018; Cerulus, 2018).

Regarding the ***evasion of US export control laws,*** a telling example is that of Amin Yu, a Chinese who had become permanent US resident and who managed - according to her own declaration in court - to obtain and export to China, between 2001-2012, systems and components for marine submersible vehicles to be used by the Harbin Engineering University and by other state-controlled entities for the development of marine submersible vehicles, unmanned underwater vehicles, remotely operated vehicles and other dual use, civil and military, equipment.

Interesting and quite surprising findings of the US research into the vectors of Chinese economic aggression in high tech and IP fields are making reference to the ***collection of scientific and technical information from open sources.*** While open sources are widely used almost everywhere in the world, most probably nowhere else are they the object of a systematic, large-scale collection, selection, analysis, matching and repackaging, as it happens in China, where more than 400 specialized research institutes employing over 60,000 staff[4] have the mandate of providing to industry, universities and research institutes comprehensive information sourced from collecting and processing of *"…millions of doctoral theses and government reports, hundreds of thousands of reference books along with thousands of foreign journals, monographs and conference proceedings."* By capitalizing on the valuable stock of scientific, commercial and technical information found from open source collection the research costs are reduced by 40 to 50 percent and the research time by 60 to 70 percent (OTMP, 2018).

4 Final remarks

China ranked the 14th in this year's *Global Innovation Index* published together by Cornell University and the United Nations' World Intellectual Property Organization. Switzerland ranks first, followed by Sweden (2nd), the US (3rd) and UK (4th). Best ranked in Asia are Singapore (8th), South Korea (10th) and China (14th), ahead of Japan (16th), Malaysia (33rd) and India (48th). China's performance is impressive given its still low ranking by GDP per capita (56th) and its late-comer statute. Besides its improving rankings as a innovative nation, its achievements in terms of fostering powerful high-tech, innovation-competitive companies are also remarkable, with Huawei ranking the 8th among the 50 most innovative companies in the world – just behind the

[4] 1985 data (OTMP, 2018).

top five Apple, Alphabet/Google, Amazon, Mirosoft and Tesla - and followed by the some other Chinese giants: Alibaba (14th), Lenovo (25th), Tencent (25th), Xiaomi (31st).

China is definitely advancing towards the statute of a great technological power, but it still has a long way to run before it can override the US and other Western countries in technology prowess and innovation. It still has to invest huge amounts of money, time and effort in basic research - which it has neglected -, as well as in technologically sophisticated sectors such as the semiconductors, which are vital for any industry of the future. It also needs to find solutions to its slowing productivity growth - as it cannot become a true innovation powerhouse without a high productivity performance (West, 2021)- and has to tame its excessive propensity to economic aggression. It is also advisable that it gives up mercantilist policies, which are proved to erode market shares, reduce revenues and, consequently, reduce investments in the next round of global innovation, curbing future development (Atkinson, 2021).

While fair competition is healthy and incentivizing, ruthless rivalry is damaging in every respect and produces no winners. Great powers should be wise enough to find the best ways to both cooperate and compete honestly.

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