KKI

POLICY BRIEF

E-2020/27

The Struggle for Technological Supremacy: China's Recent Technological Development and Its Interpretations

Harc a technológiai elsőbbségért:
Kína jelenlegi technológiai fejlődése és annak értelmezése

CSABA MOLDICZ

INSTITUTE FOR FOREIGN AFFAIRS AND TRADE

KKI Policy Brief

Series of the Institute for Foreign Affairs and Trade

Publisher:
Institute for Foreign Affairs and Trade

Reviewer:
Tamás Péter Baranyi

Copyediting:
Réka Futász

Typesetting:
Andrea Tevelyné Kulcsár

Editorial office:
H-1016 Budapest, Bérc utca 13-15.
Tel.: + 36 1 279-5700
E-mail: info@ifat.hu
http://kki.hu

ISSN 2416-0148

Abstract: This policy brief sheds light on how power relations have changed in recent years, focusing on one aspect, the technological competition between the United States of America and China. Based on selected indicators, the paper gives an overview of the struggle for technological supremacy between the two powers. The findings help answer the question whether claims concerning China secretly striving for technological supremacy can indeed be confirmed and what is probably even more important, whether this goal can be achieved.

Keywords: China, USA, tech war, technological supremacy

Összefoglaló: *Az elemzés célja, hogy megvilágítsa a hatalmi erőviszonyoknak az elmúlt években történt átalakulását, ugyanakkor a cikk e hatalmi harcnak csak egyetlen aspektusára, az Amerikai Egyesült Államok és Kína közötti technológiai versenyre fókuszál. A szerző áttekintést ad a technológiai elsőbbségért folyó küzdelem egyedi indikátorairól, ami lehetővé teszi annak a kérdésnek a megválaszolását, hogy azok az állítások, amelyek szerint Kína titokban technológiai elsőbbségre törekszik, megállják-e a helyüket, és ami talán még fontosabb, hogy ez a cél reális-e.*

Kulcsszavak: *Kína, USA, technológiai háború, technológiai elsőbbség*

Introduction

In recent years, more and more analyses have pointed out the rapid technological development in China, and pundits have often raised the question whether China has the capability to become the number one technological superpower and can overtake the United Stated in this field.

This question is relevant since beside economic and political power, technological dominance is the third crucial element needed to become a hegemonic power. After a short literature review, this paper investigates several indicators of technological development that might indicate who is going to win this competition. The databases and reports used in this paper come from Bain and Company, Bloomberg, CNBC, Forbes, GQ, OECD, Statista, the U.S. National Science Foundation, and World Bank.

There are two main reasons that make this question worth studying in the long run. The first is a question of economic policy: is China able to get the upper hand in technology development by relying on state-led economic policy tools? If the answer were to be yes, it would have long-term implications on how advanced countries implement their development policies. The other reason is more of a geopolitical nature: can China succeed in strengthening its grip on the internet and reap economic, and diplomatic benefits from this supremacy? If the answer is yes again, it would have long-term consequences for multilateral institutions.

The relevance of this paper comes from the current heated debate on China's technology achievements and their alleged threat to the USA. US-based think tank Council on Foreign Relations (CFR) formulates the fear this way: "China is closing the technological gap with the United States, and though it may not match U.S. capabilities across the board, it will soon be one of the leading powers in technologies such as artificial intelligence (AI), robotics, energy storage, fifth-generation cellular networks (5G), quantum information systems, and possibly biotechnology." This paper examines whether these fears are justified or if they are pieces in a larger geopolitical game.

The recent tone of American political discourse can be easily captured in the quote of Eric Schmidt, former chair of Google, who famously said of the Chinese: "By 2020, they will have caught up. By 2025, they will be better than us. And by 2030, they will dominate the industries of AI." In the reasoning as to why the USA must be afraid of China's technological supremacy, two elements are often emphasized. (1) By remaking cyberspace in the Chinese way, the internet would be less global and may be less open, and (2) the benefits of technological supremacy would be reaped by China and not the USA. The latter argument is more convincing, since the United States has acted more or less coherently as a hegemon since WWII, and as such tries to protect its positions as China struggles for more power and leverage in the world economy and politics. However, in both cases the behaviour of China and the USA is less the product of any grand strategy than the outcome of the characteristics of the domestic and international field in the respective countries. In the USA, corporate interests, wealth, and certain elements of the American political culture are the driving forces behind the American 'mission awareness', while the peculiarities of the Chinese political institutions, historical development (bad experiences with the West), and the interests of global Chinese firms also have a huge influence on the policies related to technological development and research.

Thus, the trade war and the political debate around Huawei in the world's technological landscape might result in a growing gap that creates (at least) two technological micro cosmoses or eco-systems. In my understanding, the communication of Huawei Corporation, whose goal is not to abandon the Android platform but develop its own Harmony OS, is a harbinger of this new world; a world in which the Chinese concept of cyber-sovereignty is much more attractive to smaller nations, who are keen to preserve their sovereignty, than a US-dominated technological environment. Some researchers underline the fact that the USA would be 'distributed', thus delegating power to several bodies when it comes to ruling the web. Adam Segal adheres to this belief: "Washington and its allies have promoted a distributed model of Internet governance that involves technical bodies, the private sector, civil society, and governments, whereas Beijing prefers a state-centric vision."

However, the delegation of different tasks does not necessarily lead to weaker control. Edward Snowden, the whistle-blower, summarized the recent American approach to surveillance in an interview with *The Nation*: "Richard Nixon got kicked out of Washington for tapping one hotel suite. Today we're tapping every American

citizen in the country, and no one has been put on trial for it or even investigated. We don't even have an inquiry into it." Thus, it is no wonder that China has recently made significant efforts to strengthen its technological independence, likely leading to two separate eco-systems, or at least to a world where (technological) permeability is decreasing.

Key Indicators of Technological Supremacy

In an ideal world, technological standards and rules would be formed and shaped in the framework of multilateral institutions, creating a level playing field for every firm and every country. However, it would be naïve to hope for such an institutional environment, and we can project a continued struggle for technological supremacy on both sides instead. In the next part of the paper, some lead indicators related to this struggle will be investigated.

According to World Bank data, China's research and development expenditure was 2.13 percent in terms of GDP in 2017, while the US figure was 2.80 percent the same year (see table 1). Since the data is given in purchasing power parity, price level differences are not relevant from this point of view. In China's case, it is not the amount spent on research and development that is stunning but how fast this amount has been growing over the last two decades. Research and development expenditures were only 0.56 in 1996 and 0.89 in 2000, while the change is not significant in the case of the USA.

Table 1
R&D Expenditure (in % of GDP)

Country Name	1997	2007	2017
China	0.6	1.4	2.1
Germany	2.2	2.4	3.0
United Kingdom	1.5	1.6	1.7
Russian Federation	1.0	1.1	1.1
United States	2.5	2.6	2.8
World	2.0	1.9	2.3

The American advantage is still significant, which is reflected in absolute numbers of research and development expenditures. The same year the USA spent 482 billion USD on R&D, China's spending was only 444 billion USD according to OECD data. We should also add that given the momentum of China's development in this area, it would not be surprising if China had overtaken the USA in the last two years. (This data is not yet available for 2018 and 2019.)

Human Resources

There are other – rather soft – figures that help us understand the development and research potential of the two countries. The number of Chinese graduate students with science and engineering degrees has increased from 337,000 in 2001 to 1.7 million in 2015, i.e. the number has increased fivefold over this period according to the STATISTA database. The growing importance of sciences can be observed in the US data as well; however, the size of the Chinese population is a key aspect in this regard. The size of the population is also key when looking at the number of wireless subscriptions: in China, this number was above 1.5 billion, while the same figure was around 400 million in the USA.

According to the US National Science Foundation's (NSF) reports, China produced the largest number of scientific publications in the year 2017, although the lead had already been taken by China in 2016, when around 426,000 papers were published by Chinese scholars, compared to 409,000 having been made available by the USA.

Large Tech Firms

Although large Chinese firms have undergone a fast and very successful internationalization process over the last two decades, the bulk of the most valuable tech companies is still from the USA and not from China.

However, looking at all firms, the picture seems to be very different. Five Chinese companies are in the top 10 most valuable companies in the world, all in the banking or insurance industry (Forbes Global 2000 list). Still, these firms make the list due to the size of the economy, not because they are leaders either in internationalization or research and development.

Table 2

Most Valuable Tech Companies Based on Market Value in 2019 (USD)

	Market value	Origin
Microsoft Corp.	1.5 trillion	US-based
Apple	1.3 trillion	US-based
Amazon	1.2 trillion	US-based
Alphabet*	1.1 trillion	US-based
Facebook	765 million	US-based
Alibaba Group Holding	654 billion	China-based
Tencent Holdings	583 billion	China-based
Samsung Electronics	354 billion	South-Korea based
Taiwan Semiconductor Manufacturing Company (TSMC)	312 billion	China-based**
Intel Corp.	300 million	US-based

Notes: * Alphabet includes Google

** Although Taiwan is part of China, the assessment of China's technological development would be distorted by including TSMC in the group of Chinese flagship companies.

When analysing the first 10 tech companies based on their market value (see table 2), it is worth noting that only two Chinese firms make it to the top 10 most valuable companies. (Although Taiwan Semiconductor Manufacturing Company is based on the island of Taiwan, hence it could be categorized as a China-based firm, for practical research purposes this paper mainly focuses on the technological development of mainland China, so TSMC was not included in China's technological base here.)

R&D Spending at a Corporate Level

Not only the market value of the given enterprise but also research and development expenditures must be considered when evaluating the competition of the two countries. According to Bloomberg data (cited by Jeff Desjardins), in 2017 the majority of R&D spending came from American firms, and only Huawei was listed among the top twenty firms. It is worth pointing out that the largest spenders on research and development tended to be pharmaceutical firms ten years ago. This trend might later have a positive effect on the ranking of Chinese firms, since Chinese tech firms' global competitiveness is much better than that of the Chinese pharmaceutical companies.

Venture Capital Market

A special corporate sector is the segment of small technology firms that have a great need for fresh capital but also have great potential for future growth. According to the data in the Global Private Equity Report 2019, Chinese internet and technology firms are gaining a growing share in global private and equity investment. In 2014, the share of Chinese firms was just 4 percent, which expanded to a staggering 32 percent in 2018. Due to this trend, the gap between the USA and China has been rapidly closing, although the USA is still number one in this investment segment with 47 percent (2018). We must point out that the internet and tech companies in China have been gaining ground in the investment segment, at the expense of other sectors. In 2018, the Chinese private equity sector was dominated by internet and tech firms, where 83 percent of the aggregate venture capital was invested, and only the rest (17 percent) was spent on other sectors.

The market growth potential of firms is partly determined by the size of the market, including purchasing power; however, the willingness of customers to use new technology (apps) also contributes to this process. It might not be a surprise that Chinese users surpass Americans in using online entertainment, payment, etc. services due to the size of the Chinese population, although this explanation does not provide a rationale for an 80 times larger value of transactions in China. (In 2018, this figure was 9 trillion USD in China and only 112 billion USD in the US, the Global Private Equity Report points out.)

Table 3

Research and Development Spending at a Corporate Level (2017, billion USD)

	Billion USD	Country of origin	Sector
Amazon	17.4	US-based	Technology
Volkswagen	15.1	Germany-based	Automotive industry
Alphabet*	14.5	US-based	Technology
Intel	12.8	US-based	Technology
Samsung	12.8	Korea-based	Technology
Microsoft	12.7	US-based	Technology
Roche	11.7	Switzerland-based	Pharmaceutical sector
Huawei	11.2	China-based	Technology
Apple	10.8	US-based	Technology
Merck	10.3	US-based	Pharmaceutical sector

Note: * Alphabet includes Google

The Semiconductor Industry

Another special segment is the semiconductor industry, where Chinese goals are clear: Chinese guidelines specify that the goal is to get domestic firms to produce 70 percent of microchips by 2025. The implementation of this goal can threaten the American dominance in the long run; however, significant efforts must be made by China, since only 16 percent of semiconductors were designed in China in 2018, and according to Sanford C. Bernstein (cited by the CNBC), the revenue of Huawei's chip unit was just about one-tenth of the revenue booked by US chip giant Intel. These two pieces of data clearly show that the journey will be long for China when catching up with the USA in this segment.

5G and Artificial Intelligence

The 5G segment is one of the most important battlefields, and it is dominated by two Chinese giants, Huawei and ZTE, whose combined market share in the 5G infrastructure market is estimated to have been around 40 percent in 2019. The report of the Dell'Oro Group focuses on the telephone equipment market, where Huawei's share was 28 percent, while the ZTE group had a market share of 8 percent in 2018. This segment is dominated by seven producers (Huawei, Nokia, Ericsson, Cisco, ZTE, Ciena, and Samsung).

Both countries spend significant amounts on the development of artificial intelligence. According to CNBC data, China spent 4.9 billion USD on AI in 2017, while the USA only spent 4.4 billion USD the same year. The other significant difference is in the number of investments, since China spent 4.9 billion USD on AI while only carrying out 19 investment transactions. The number of investments was 155 in the case of the USA. The gap also reveals differences between the two economic regimes. In the Chinese state-led economic model it is less difficult to accumulate

financial resources; however, the American approach is less likely to run the risk of malinvestment, and the course can be more easily adjusted to new conditions.

Beside the value of AI investments, there are other factors, too. The report of the Center for Data Innovation compared China, the European Union, and the United States in this field, with the main finding that "despite China's bold AI initiative, the United States still leads in absolute terms. China comes in second, and the European Union lags further behind. This order could change in coming years as China appears to be making more rapid progress than either the United States or the European Union." The report analysed six dimensions: (1) talent (number of AI researchers, number of top AI researchers based on H-index, participation in academic conferences, etc.); (2) research (number of AI papers, field-weighted citation impact, top-100 software and computer service firms for R&D spending, etc.); (3) development (number of AI start-ups, number of acquisitions, etc.); (4) adaptation (number of workers adopting or piloting AI); (5) data (fixed-band subscriptions, number of individuals using mobile phones, electronic health data, etc.); (6) hardware (number of firms in top 15 for semiconductor sales, number of firms in top 10 for semiconductor R&D spending, number of firms designing AI chips, etc.). The unique feature of the analysis is that the authors of the paper adjusted the numbers and thus their ranking by the number of workers or individuals.

Table 4
Ranking in AI Competition

	China	USA	EU
Talent	3	1	2
Research	3	1	2
Development	3	1	2
Adaption	1	3	2
Data	1	2	3
Hardware	2	1	3

Summary

After this short review of some of the lead indicators of technological development, it is clear that the USA still has dominant positions in more segments of the technological competition than China (see again these indicators summarized in table 5, where x stands for a dominant position in the given field). Those indicators where China is doing better than the USA are simple to be explained by the size of the country (market, population):

- the number of wireless subscriptions,
- the total number of scientific publications (2017),
- and the number of graduate students with science and engineering degrees (BA) (2015).

Alternatively, there are new areas where the Chinese approach to concentrate financial and human resources, applying more and more direct state intervention and guidance, has brought substantial results in recent years:

- investment in artificial intelligence technology,
- and the 5G infrastructure market.

However, the dynamic of the development is difficult to capture by the more-or-less static lead indicators we used in this paper. This dynamic and our general assessment corroborated by the Bloomberg Innovation Index, where China was 15th in the 2019 ranking, while the USA, number one in 2013, had slipped to the 9th position. (China became the 2nd country in patent activity and the 15th in efficiency.)

Similar trends are discernible when looking at the results of the IMD World Digital Competitiveness Ranking in 2019. The ranking only focuses on the subsegment of the technological competition between the USA and China. In 2019, the largest jump in the ranking was showed by China, which moved from the 30th to the 22nd position. The main improvement took place in the knowledge sector (18th) and scientific concentration (from 21st to 9th). We should add that the whole Asian region performed better than the rest of the world, but even within this group, the fastest gradual improvement was that of China. With this performance, China surpassed Japan and France. At the same time, the USA is still number one in this ranking. The pattern repeats itself here again: enormous improvement in China, but the USA is the leading force.

We must emphasize that one of the reasons why the story of China's technological rise is narrated and interpreted that differently in the literature and the media is the speed of development in China, and the simultaneous American stagnation or slide in many areas. The Bloomberg Innovation Report underlines the fact that China's strong performance reflects a build-up for the trade war. The strong need was, according to this interpretation, initiated by a confrontative American foreign policy.

The domestic market size which these firms can rely on is of utmost significance for the innovation and development process of new technologies. At the same time, access to foreign markets is also a crucial element. The dispute whether Chinese firms are granted access to the mature European market is crucial. We cannot deny the importance of the Belt and Road Initiative launched in 2013, and the 17+1 cooperation in this aspect. Segal summarizes it this way:

> Beijing is likely to have its biggest impact on global Internet governance through its trade and investment policies, especially as part of the Belt and Road Initiative, a massive effort to build infrastructure connecting China to the Indian Ocean, the Persian Gulf, and Europe. Along with the more than $50 billion that has flowed into railways, roads, pipelines, ports, mines, and utilities along the route, officials have stressed the need for Chinese companies to build a "digital Silk Road": fiber-optic cables, mobile networks, satellite relay stations, data centers, and smart cities.

Table 5
Lead Indicators of Technology Development Competition
Between China and the USA

	USA	China
Investment in artificial intelligence technology	-	x
AI competition based on several indicators (see CDI report)	x	-
National champions' spending on R&D (based on the figures of the top 20 companies)	x	-
Private equity and venture capital investments	x	-
R&D expenditure in absolute numbers	x	-
R&D expenditure in terms of GDP (2017)	x	-
Semiconductor industry	x	-
The 5G infrastructure market		x
The number of graduate students with science and engineering degrees (BA) (2015)	-	x
The number of most valuable tech companies in the top 10	x	-
The number of wireless subscriptions	-	x
The total number of scientific publications (2017)	-	x

Source: own compilation

The difference between the American and Chinese approaches is that the USA can rely on its already existing self-sufficient technological ecosystem created by American firms and supported by its political allies; however, China is just about to build another one, which will most likely to be a closed-loop ecosystem with self-sufficiency at almost every stage. To put this in another perspective, to achieve self-sufficiency, Chinese economic development policies must be clearer, drafted and implemented in a more decisive way, but this is not a problem, since Chinese politics is willing to intervene in the economy and provide public sources for innovation. Based on the indicators, this paper has shown that China still has a long way to go to dominate the technological development, and even self-sufficiency still requires significant efforts from China.