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China's Tech Rush

How the Country's Strategic Technology Campaign is Shaping Markets

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China is in the midst of a dramatic campaign

to acquire and develop advanced technologies. The effort is motivated by the government's desire to move up the economic value chain and reduce dependency on foreign-controlled technology. The goal is for Chinese firms to establish leading positions in emerging industries, including new energy vehicles, artificial intelligence (AI), and advanced semiconductors. To support this effort, the Chinese government is directing vast amounts of resources towards encouraging domestic innovation, financing industrial upgrading, and supporting the acquisition of overseas technology.

China's recent history is replete with top-down government initiatives designed to advance the country's technological and industrial capabilities. The current campaign differs from the past due to its greater embrace of the private sector. Many large and innovative private Chinese companies are playing a leading role in the government's latest technology drive. Additionally, significant amounts of private capital are being raised to augment the state funds financing these initiatives. The fusion of state and private efforts gives the current effort far greater potential effectiveness.

As China attempts to move up the technological ladder, the industries targeted by its campaign may be fundamentally reshaped. A flood of resources pouring into an industry can lead to rapid innovation and growth, but it can also result in large amounts of wasted and irrational investment. Additionally, closer integration between the government and the country's leading technology firms may further entrench their dominant positions. As China's rush to advance its technological capabilities continues, the impact of these policies will be felt across both the Chinese economy and the world for years to come.

A History of Top-Down Government Technology Campaigns

Technology and the power derived from it have loomed large in China's national psyche for the past two centuries. China's history is littered with moments when the country's relative technological weakness was exploited against it to devasting effect. Mindful of this past, Chinese governments stretching back to the Qing Dynasty have sought to acquire advanced technologies to offset these weaknesses and to augment national power.

Since taking power, the Chinese Communist Party has been an ardent promoter of top-down national campaigns to acquire and develop technology. In the second half of the 1950s, China began a coordinated push to develop strategic technologies via the 12-Year Science and Technology Plan. The government devoted significant financial, human, and strategic resources towards developing a nuclear bomb and hydrogen bomb. The total cost of this effort was immense and involved hundreds of research institutes, universities, and factories at a time when the country was desperately poor and struggling with famine.[1] China managed to launch its first satellite in 1970, becoming the fifth nation to do so. The launch was only two months behind that of Japan, a country that was far more developed in terms of science and industry at the time.[2]

When China began its economic reforms in 1978, advancing the country's science and technology capabilities took center stage as part of Deng Xiaoping's Four Modernizations. That year, the government produced a plan to fund research in 27 sectors, 108 research projects, and 8 comprehensive projects focused on agriculture, energy, materials, computers, lasers, space, physics, and genetic engineering.[3] Since then, as shown in Figure 1, the government has launched numerous science and technology campaigns to promote technological development.

Figure 1. China's Science and Technology Campaigns

1982	Key Technologies Research and Development Program	Upgrade and restructure industries and requirements for national economic construction.[4]
1986	National High Technology Research and Development Program (863 Program)	Promote applied and basic research in seven key areas related to national security and economic competitiveness.[5]
1988	Torch Program	Commercialize new technology and cultivate specialized industry clusters through the creation of technology business parks and incubators.[5]
1997	National Plan on Key Basic Research and Development (973 Program)	Bolster basic research in fields such as agriculture, energy, information technology, environmental resources, populations and health, and materials.[6]
2006	National Medium- and Long-Term Plan for the Development of Science and Technology (2006–2020)	Reduce dependency on foreign technologies, promote indigenous innovation and the development of strategic sectors.

In 2006, the Chinese State Council launched a major new technology campaign, called the National Medium- and Long-Term Plan for the Development of Science and Technology, often referred to as the MLP. The plan was positioned as a blueprint for science and technological development for the country over the next 15 years.[3] Motivating the effort was the belief that reducing reliance on imported technology was essential to the country's economic future, and that

critical technologies that determine economic strength and national security would never be sold to China.[7] To overcome this challenge, the MLP called for indigenous innovation and leapfrogging ahead to new technologies in a variety of fields. The plan was also notable for its call for enterprises to place a central role in promoting innovation, reflecting the increasing role of the market forces. Despite strong support by the government, the MLP ultimately failed to meet expectations and resulted in many wasted investments.[8] A 2012 assessment by the Communist Party and the State Council concluded that China's "capacity for innovation remains inadequate" and that the country's scientific and technological level was "unable to meet the demands of economic and social development and international competition."[9] A key reason identified in the report was lack of coordination among government bodies and insufficient involvement of the private sector. Although the plan did not achieve many of the breakthroughs it targeted, it served as a useful model for the larger and more vigorous technology campaign to follow.

The Xi Jinping Era Technology Campaign

President Xi Jinping's ascension to power came at a time of decelerating growth in the Chinese economy and increasing concerns about the country's dependence on foreign technology. Following a few years of stimulus-driven growth after the global financial crisis of 2007–2008, the Chinese economy began to decelerate rapidly. Gross domestic product (GDP) growth slowed from 10.6% in 2011 to 6.9% in 2015.[10] Around this time, Chinese economists began to speak of a "New Normal" that would see China transitioning to a permanently slower period of growth. A related concern was that China would fall into the "middle income trap," a term that refers to fast developing countries whose growth slows when they begin to reach middle income levels and fail to transition to high income status.

Policymakers focused intensely on the role played by China in the manufacturing global value chain. China is the world's manufacturing workshop, but it captures very little of the total value of the high-tech products it produces because of its reliance on foreign technology. A classic example is the Apple iPhone, which is assembled in China but relies on overseas suppliers for most of its components and is designed by Apple engineers in California. As a result, Chinese suppliers only capture 0.3% of total supplier gross profits, compared to South Korea, Japan, and Taiwan which capture 9.1%, 11.8%, and 29.2%, respectively.[11] China is relegated to supplying low-cost labor and as a result captures very little of the iPhone's total profits.[12] As China's reliance on foreign technology has grown, so has the cost. Between the years 2005 and 2017, China's annual payments for the use of foreign intellectual property increased from USD 4 billion to USD 29 billion.[13]

Reliance on foreign technology is more than a problem of profits – it can be linked to critical issues of national security and economic dependency. The increasing scope of economic conflict between the U.S. and China has raised the possibility that access to critical technologies could be disrupted or terminated altogether. In April 2018, ZTE Corporation, a large Chinese telecommunications equipment manufacturer, was banned by the U.S. Department of Commerce from purchasing any goods from American companies. The ruling, a result of the company's failure

to honor an agreement involving Iranian sanctions, was effectively a corporate death sentence as many of its key components came from U.S. suppliers. While the restrictions were later lifted after a high-level overture by the Chinese government, the incident served as a sharp reminder of the dependency of many Chinese firms on foreign technology. Chinese firms have also encountered barriers when they attempt to acquire overseas companies with advanced technology. The U.S. Congress recently strengthened the powers of the Committee on Foreign Investment in the United States (CFIUS) to block Chinese investments, and several European acquisitions by Chinese companies have faced opposition from local European political leaders.

Acutely aware of these issues, President Xi Jinping has been a vocal advocate of advancing the country's technological capabilities. Soon after taking power in 2012, he began emphasizing the importance of mastering "core technologies" so that China would not be so reliant on foreign technology.[14] Xi identified foreign control over key industries such as semiconductors as both an economic and a political danger to China. In 2013, the State Council released a document that identified steps for strengthening the role of enterprises in promoting innovation through increasing investment, establishing research and development (R&D) centers, supporting the commercialization of research, and promoting partnerships between research institutions, companies, and industry alliances.[15] In 2014, Xi ordered the National Development and Reform Commission (NDRC) and the central government's Financial and Economic Affairs Group to craft a detailed innovation-driven development strategy for the economy.[8] The document that emerged from this effort emphasized the central role of enterprises and market competition in encouraging innovation and called for removing structural barriers, such as monopolies, that prevent entry of new firms into a sector.[16] A formal plan, the National Innovation-Driven Development Strategy Outline (National Innovation Strategy), was jointly released in 2016 by both the Communist Party and the State Council. The plan was notable for its goal of China becoming an innovative nation by 2020, an international leader in innovation by 2030, and a world powerhouse of scientific and technological innovation by 2050.[17]

These issues also became a prominent focus in China's 13th Five-Year Plan which was being drafted during this period. The plan declares that innovation is the primary driver of economic development and that China should seek to make breakthroughs in strategic and frontier fields.[18] It identifies next generation information and communications, new energy, new materials, aeronautics and astronautics, biomedicine, and smart manufacturing as core technologies that should be targeted with government support. In line with the themes of the National Innovation Strategy, the plan emphasizes that enterprises are the key engine of innovation and calls for the creation of a competitive marketplace that strengthens innovation. A follow-up plan by the Ministry of Science and Technology, the 13th Science and Technology Plan, included a number of targets for 2020 for research spending and patent production, to be implemented by various government industries.[19] Figure 2 shows the targets of this plan.

"Core technology is our biggest lifeline and core technology controlled by others is our biggest danger. Without mastering core technology, we will be squeezed by the throat, led by the nose, and forced to follow the lead of others."

– Xi Jinping
President of the People's Republic of China
April 2018

Figure 2. 13th Five-Year Science and Technology Plan Targets

	2015 Level	2020 Target
National Comprehensive Innovation Global Rank	18	15
Contribution of Science and Technology to Economic Growth (%)	55.3	60.0
Research and Development Funding (% GDP)	2.1	2.5
Research and Development Staff (Per 10,000 employees)	48.5	60.0
Operating Income of High-Tech Enterprises (Renminbi (RMB) trillion)	22.2	34.0
Knowledge-Intensive Services Value Added (% GDP)	15.6	20.0
R&D Spending for Large Industrial Enterprises (% main business income)	0.9	1.1
International Ranking for Scientific Papers Citations	4	2
Number of PCT Patent Applications (10,000 applications)	3.1	6.1
Number of Invention Patents Per 10,000 People	6.3	12.0
National Technology Contract Transaction Amount (100 million)	9,835	20,000
Proportion of Citizens with Scientific Backgrounds (%)	6.2	10.0

Source: State Council[20]

The Xi Jinping Era technology campaign builds upon previous efforts, particularly those of the 2006 MLP. However, compared to the past, the current campaign places greater emphasis on the leading role played by enterprises (private and state-owned),[21] the mobilization of new funding channels, and the strategic imperative of reducing reliance on core technologies controlled by foreign suppliers.

Policy Frameworks

There are three key policy frameworks that underpin Xi's technology campaign: Made in China 2025, the Internet Plus Action Plan, and the Next Generational Artificial Intelligence Development Plan. While each of these policy frameworks has a different focus, they overlap and mutually reinforce each other.

Made in China 2025: In 2013, the Chinese Academy of Engineering and the Ministry of Industry and Information Technology convened a group of over 150 scholars and technical experts to create a report addressing how China could become a manufacturing superpower.[22] The report ultimately coalesced into the Made in China 2025 plan that was adopted by the State Council in 2015. The plan states that China's national prosperity depends on achieving a strong manufacturing industry and that while the country's manufacturing base is large, it has significant gaps with respect to efficiency, quality, and level of technology.

Taking a note from industrial policy frameworks in other countries, like Germany's Industry 4.0, the Made in China 2025 plan identifies the role that advanced technology and internet connectivity will have in shaping the competitive landscape of the manufacturing sector. The plan calls for manufacturers to become more efficient through industrial upgrading and the integration of technology into domestic manufacturing operations. Breakthroughs will be sought

in key technologies, enabling Chinese firms to dramatically reduce their reliance on foreign suppliers and vulnerability to overseas disruptions. The plan sets targets for reducing the reliance on foreign suppliers for essential spare parts and key materials to less than 30% by 2025.

Made in China 2025 sets out the following timeline:

- By 2020, consolidate China's status as a great manufacturing power and achieve the integration of the country's manufacturing sector with information technology.[23]
- By 2025, greatly enhance the overall level of quality and innovation across the manufacturing sector and create new internationally competitive multinational corporations and industrial clusters.
- By 2035, China's manufacturing sector will enter the ranks of the world's manufacturing powers, having achieved breakthroughs in key industries and global leadership innovation leadership across several sectors.

Within the plan, as shown in Figure 3, there are 10 strategic industries targeted for major breakthroughs.[22]

Figure 3. Made in China 2025 Priority Sectors

- New generation IT, including integrated circuits, communication equipment, and industrial software
- High-end digitally controlled machine tools and robots
- Aerospace and aeronautic equipment
- Ocean engineering equipment and advanced shipping
- Advanced rail transportation equipment
- Energy-efficient and new energy vehicles
- Electrical power equipment
- High-end agricultural equipment
- Advanced new materials
- Bio-medicine and advanced medical equipment

Source: State Council[23]

The Made in China 2025 plan calls for enterprises to take the lead role in promoting innovation and for the initiative to be both market-oriented and government-guided. It includes a long laundry list of actions the government will take to support the effort, including funding research into core technologies via national science and technology projects; promoting collaboration between the government, enterprises, and universities and research institutions; and building a series of industrial technology research bases. Additionally, the plan pledges government support for major strategic projects, industrial technology upgrading, mergers and acquisitions, and cross-border expansion. Undergirding these efforts are numerous financial support policies and fiscal and tax incentives.

"Innovation is the primary driving force for development."

– China's 13th Five-Year Plan (2016–2020)

Internet Plus Action Plan: Premier Li Keqiang announced the Internet Plus Action Plan in 2015, calling for the integration of the internet into all areas of the economy in order to increase innovation, entrepreneurship, and industrial upgrading. From e-commerce to online banking to social media, China has a large and dynamic

consumer internet sector that is on the cutting-edge of many new technologies. The Internet Plus Action Plan seeks to harness this dynamism in order to revitalize legacy industries and speed up economic development. The plan identifies mobile devices, the Internet of Things (IoT), cloud computing, and big data as key tools for this transformation.

The initial target of the Internet Plus plan was for the internet to become further integrated into all aspects of the economy by 2018 and emerge as a driver of new economic growth. By 2025, the plan seeks to create an innovation-driven economy that is underpinned by a networked, intelligent, and service-oriented industrial ecosystem. Figure 4 highlights the specific areas of the economy where the plan seeks to integrate internet technologies.

Figure 4. Key Internet Plus Actions

- Internet + Venture Innovation
- Internet + Collaborative Manufacturing
- Internet + Modern Agriculture
- Internet + Smart Energy
- Internet + Inclusive Finance
- Internet + Public Services
- Internet + Efficient Logistics
- Internet + E-Commerce
- Internet + Convenient Transportation
- Internet + Environment Protection
- Internet + Artificial Intelligence

Source: State Council[24]

The Internet Plus plan calls for accelerating China's plan to roll out a national broadband network, creating open data platforms among large internet companies and telecoms, supporting technology startups, encouraging cooperative industrial innovation and technology networks, and removing market access barriers in the internet sector. It pledges to intensify government fiscal investment to promote innovation and the development of technology, give tax incentives to firms researching internet technologies, and promote angel and venture capital investment in the internet sector. In 2017, the Cyberspace Administration of China and the Ministry of Finance launched a 100 billion renminbi (RMB) fund to support internet companies and the Internet Plus plan through equity investments.[25] Several Chinese banks have pledged to support the initiative through providing credit.

Financial technology (fintech) is a leading example of the potential applications of the Internet Plus plan. The proliferation of smart phones in China has created the opportunity for the widespread use of mobile payments. Chinese firms like Ant Financial and Tencent have seized this opportunity to develop massive online payment platforms, transforming the traditional payments industry. China now has 50 times more mobile payments per year than the U.S., and several Chinese companies are world leaders in the field.[26] The Internet Plus plan provides support for these firms as they apply these internet technologies to other industries in China and expand into international markets.

The Next Generation Artificial Intelligence Development Plan: Recognizing the dramatic advances in artificial intelligence (AI) in recent years and its potential impact on the economy, society, and national defense, Chinese policymakers put

forward a plan in 2017 to develop the domestic AI industry. The plan calls for the AI industry to be developed along market principles and led by developments in technology (as opposed to government policy). It targets the integration of AI into all industrial areas in order to increase productivity, move up the value chain, and support the real economy. As shown in Figure 5, the plan directs support to several new AI-driven industries and identifies other existing industries that can be transformed via the integration of AI technologies.

Figure 5. The Next Generation Artificial Intelligence Development Plan Industries

New AI-Driven Industries:	AI-Integrated Existing Industries:
Smart Software and Hardware	Smart Manufacturing
Smart Robots	Smart Agriculture
Smart Delivery Tools	Smart Logistics
Virtual and Augmented Reality	Smart Finance
Smart Terminals	Smart Commerce
The Internet of Things	Smart Household Goods

Source: State Council[27]

The Next Generation AI plan sets a goal for China to converge with the most advanced levels of AI research in the world by 2020 and the establishment of an internationally competitive AI industry.[28] By 2025, the plan calls for major breakthroughs in AI, driven by autonomous learning, and for integration of AI throughout the economy in areas like intelligent manufacturing, advanced medicine, smart cities, and national defense. The plan targets AI as the driving force behind the upgrading of China's industrial sector and overall economic restructuring. By 2030, China aspires to be the world's leading source of AI innovation and achieve deep integration of AI throughout the country's industrial chain. By this time, China intends for its AI industry to exceed RMB 1 trillion, and for AI-linked industries to exceed RMB 10 trillion.

The government is coordinating the development of the industry and promoting information sharing. The Ministry of Science and Technology established the New Generation AI Strategic Advisory Committee and the NDRC created the China AI Industry Development Alliance.[29] The plan calls for the government to construct a series of national AI industrial parks and innovation bases. Financial support will be accomplished through mobilizing public and private capital, providing tax incentives, and supporting mergers and acquisitions and overseas expansion. Local governments, including Beijing, Shanghai, Nanjing, and Wuhan have competed fiercely to establish local AI industry clusters. AI startups are promised funding, office space, and subsidized housing in the hopes of attracting talent.

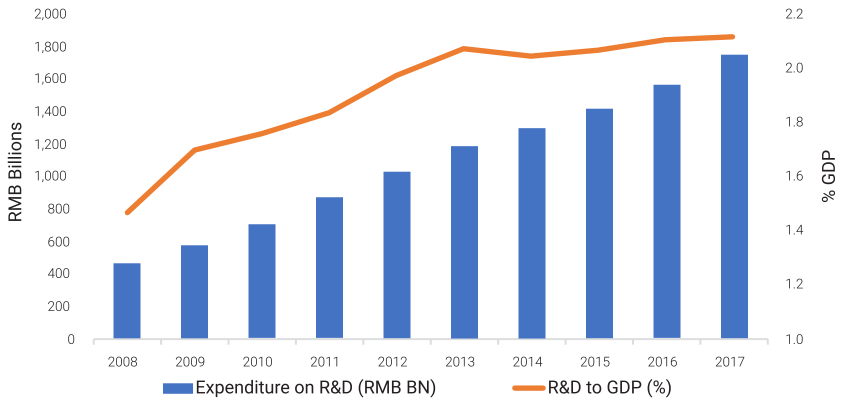
Funding and Support

Support for China's technology campaign comes from both state, private, and hybrid public-private efforts.

Central Government: The Chinese central government provides direct support via funding to universities and national laboratories for basic research, often under the framework of the 863, 973, and Torch programs noted in Figure 1. The central government also runs a program called The Thousand Talents Plan which recruits skilled scientists, professionals, and entrepreneurs to come to China and work in universities, research and development institutes, state-owned enterprises, and as part of national science and technology projects.[30] Participants in the program are provided with competitive salaries, living quarters, and funding to conduct their research.

Tax incentives for R&D spending are another major source of support. As shown in Figure 6, overall R&D funding in China reached an estimated RMB 1,750 billion (USD 279 billion) in 2017, representing 2.1% of GDP and an increase of 71% since 2012.[31] Three quarters of the funds come from Chinese enterprises, with technology firms accounting for more than half of the overall total.[32] China applies a preferential income tax rate of 15% on technology companies (versus the typical rate of 25%) and allows for a 150% tax deduction for eligible R&D expenditure.[19] As of the end of 2016, 80,000 technology companies – approximately one-fifth of all industrial and manufacturing companies in China – were taking advantage of the lower tax rate.[19] In April 2017, further tax subsidies were enacted for venture capital and angel investors that make investments into scientific and technology start-ups.[33]

Figure 6. China's R&D Expenditure



Source: Wind Information.

Local Government: Local governments in China are providing significant support to the technology campaign. Their efforts include:

- numerous dedicated investment funds which provide financing to companies in strategic industries
- hundreds of newly established high-tech zones across China. Local governments entice companies to set up within the zones by proving favorable financing, cheap land, office space, and subsidized housing.[34] The number of companies in national high-tech zones exceeded 91,000 in 2016 and non-state

enterprises accounted for more than 95% of the companies operating in these zones.[35]

- the establishment of technology business incubators, which increased by almost five-fold between 2008 and 2016, reaching 3,255.[35] The incubators and the start-ups and angel investors associated with them receive support and tax incentives from local governments.[36]

Financial Institutions and Capital Markets: Further support for the technology campaign is provided through directed lending from state-owned financial institutions. China Development Bank, one of China's three policy banks, has committed to RMB 300 billion in financing for Made in China 2025 initiatives.[37] Another policy bank, the Export-Import Bank of China, has pledged support for the overseas expansion of manufacturing enterprises as part of the initiative.

The government has pushed for easier access to financing for enterprises involved in the technology campaign. New policies direct financial institutions to support enterprises participating in the campaign.[38] Financial institutions are encouraged to provide low-cost financing to companies in strategic industries, support mergers and acquisitions, and expand abroad. Banks are directed to provide funding to small and medium enterprises and be more open to granting unsecured loans and accepting intellectual property and receivables as collateral.[39] Regulators are encouraged to make it easier for enterprises to issue bonds, including convertible bonds, and list on China's Growth Enterprise Board and New Third Board stock exchanges.

State-Guided Investment Funds: At the central, provincial, county, and city levels, government agencies have established state-guided investment funds. These funds are formed to promote the development of a specific industry, encourage innovation more broadly, or finance the restructuring of existing enterprises. State-guided investment funds are a unique form of public-private partnership, in which the government contributes initial seed capital and hires professionals to manage the investments.

Outside investors, often a mix of state-owned and private enterprises, enter the fund as limited partners. The investors are often enticed by implicit government guarantees for investment returns. Through raising outside capital, the Chinese government is able to mobilize significantly more funding for these initiatives. The implementation of professional management for the funds helps improve the efficiency of outcomes. Funds seek a balance between the underlying return on a potential investment and its overall policy impact.

Figure 7. Select National State-Guided Investment Funds

- The National Integrated Circuit Fund
- The Advanced Manufacturing Industry Investment Fund
- The National Strategic Emerging Industries Investment Guiding Fund
- The Made in China 2025 Strategic Cooperation Fund
- The Internet Investment Fund
- The National Fund for Technology Transfer and Commercialization
- The China Reform Holdings Fund

In the past several years, the number of state-guided investment funds has proliferated. At the national level, a plethora of funds have been created, with missions ranging from supporting the development of the semiconductor industry to helping state-owned enterprises upgrade their technological capabilities (see Figure 7). Province-level subsidiaries exist for many of these funds, focusing on local projects and often co-investing with national funds on projects. One such example is the creation of an RMB 10 billion blockchain investment fund by the city of Nanjing and a similarly sized fund by the city of Hangzhou.[40] By the first half of 2018, there were more than 1,000 state-guided investment funds, with a combined target to raise more than RMB 5.5 trillion.[41,42]

State-Invested Technology Funds: In addition to the more-directly controlled state-guided investment funds, numerous quasi-private technology funds have been established with money from state-owned funds. These state-invested funds are more akin to traditional private equity groups with a significant proportion of capital coming from state-owned entities. These funds may support policy initiatives as part of their activities, but they tend to be more market-based in their investments. One such fund is the China New Era Technology Fund, which

CASE STUDY

Hou An Innovation Fund, a State-Invested Technology Fund

The Hou An Innovation Fund is a clear example of the state and private partnerships that are a hallmark of the current technology campaign. The fund was formed in 2017 with financial support from China Investment Corporation, the Silk Road Fund, Temasek, Shumyip Group, Hopu Investments, and ARM Holdings (see table below). The group targeted an initial USD 800 million in capital to be raised for investing in mobile internet, IoT, and AI.[49]

Investors in Hou An Innovation Fund

Investor	Type
China Investment Corporation	China's sovereign wealth fund.
Silk Road Fund	A state-guided investment fund dedicated to promoting the Belt and Road Initiative.
Temasek	Singaporean sovereign wealth fund.
Shumyip Group	Conglomerate owned by the Shenzhen government.
Hopu Investments	A politically-connected Chinese private equity fund.[50]
ARM Holdings	A leading semiconductor design firm owned by Softbank in Japan.

As testament to the investment fund's political connections, its launch ceremony was attended by representatives from the Ministry of Science and Technology, the Ministry of Industry and Information Technology, the National Development and Reform Commission, the city and provincial party committees of Guangdong and Shenzhen, and the mayor of Shenzhen.[51]

In June of 2018, Hou An innovation Fund purchased 51% of ARM Technology China for USD 775 million. Announcing the investment, Softbank, the parent company of ARM Holdings, explained that the deal will facilitate the licensing of ARM semiconductor technology to Chinese companies and the development of ARM technologies in China.

received its initial capital from China Merchants Bank, a state-owned financial institution, and other Chinese investors.[43] The fund will raise outside money from other investors and will be jointly managed by two investment firms, one Chinese and one from the UK. Other state-invested funds have established overseas funds that operate in areas like Silicon Valley where they can have access to advanced overseas technology. Examples of these funds include Danhua Capital, Oriza Ventures, and SAIC Capital. Zhongguancun Development Group, a venture capital group owned by the Beijing municipal government, operates incubators in Silicon Valley and Boston.[44]

Private Enterprise Support: Support for China's technology campaign by private enterprises, particularly China's homegrown technology champions, has been critical. Alibaba's co-founder and Executive Chairman Jack Ma has echoed the official mantra that China needs to break free from reliance on foreign core technologies, notably referring to the U.S. stranglehold over the semiconductor market.[45] To that end, Alibaba has invested in multiple semiconductor firms to boost the development of the domestic industry. Tencent's chairman Pony Ma describe the ZTE incident as a "wake up call" and pledged that his company will support the development of the semiconductor industry in China.[46]

"The recent ZTE incident made us see clearly that no matter how advanced our mobile payment is, without mobile devices, without microchips and operating systems, we can't compete competently."

– Pony Ma
Chairman, Tencent
May 2018

With respect to the AI and Internet Plus initiatives, China's private sector technology companies have been the key drivers of the effort. Baidu, Tencent, and Alibaba have made large investments in AI even before the government's Next Generation AI initiative. According to CB Insights, China accounted for 48% of global equity investment in AI startups in 2017, up from only 11.3% in 2016. Internet Plus has also received major support from China's tech giants. The consumer internet and fintech industries in China have grown by leaps and bounds due to the internal R&D spending of these companies and their numerous investments in start-up companies. The Internet Plus plan seeks to support the efforts of these companies.

As official embrace of private enterprises has grown, the government has become more assertive regarding the establishment of Communist party cells in private enterprises. China's large internet companies have established party cells throughout their operations to placate these demands. The government has also created industry groups designed to control the actions of companies. In May 2018, the China Federation of Internet Societies, of which all the major tech companies are members, was established to oversee the operation of member organizations and promote the development of party organizations in the industry.[47]

Impact on Markets

China's technology campaign will have a significant effect on the industries it targets. The activities of firms operating within these industries will be shaped by the flood of resources and support that accompany the campaign. Firms that are skilled in accessing this support will have a distinct advantage, and this may determine the winners and losers across industries. Importantly, even if many of

the underlying investments ultimately prove to be unsuccessful, the technology campaign can lead to a fundamental restructuring of the competitive landscape.

Disrupting Industries via New Entrants: Government support through the technology campaign can disrupt existing industries by supporting new entrants, while in other industries it reinforces the dominance of leading firms. The campaign seeks to direct resources and support to many new and emerging fields and aid startups in these fields through cheap loans, land, office space, and seed capital. This type of support can be critical in helping fledgling companies survive through the often-volatile early years of a business. As firms grow, investment from state-guided funds or government-linked private equity and venture capital funds can support further expansion. Moreover, the imprimatur of government support can prove invaluable in securing bank lending and displaying credibility to potential clients. The competition across localities in China to establish leading positions in these emerging industries adds to the number of disruptive entrants. Driven by government inducements, firms are likely to flood into industries targeted by the technology campaign. Artificially low funding costs and other forms of support can stifle the normal churn that causes less competitive companies to go out of business. The result of all of this can be an unsustainable boom in the number of firms in an industry.

Entrenching Existing Market Leaders: At the same time, the technology campaign can also reinforce existing hierarchies within industries. The emergence of homegrown technology giants such as Alibaba, Tencent, and Baidu largely occurred independent of Chinese government support. However, reflecting the increasing openness to involvement by the private sector in the technology campaign, the Chinese government has subsequently co-opted these firms. In turn, these firms have actively supported the underlying initiatives of the technology campaign. For example, the NDRC has selected Baidu to lead the National Engineering Laboratory of Deep Learning Technology in conjunction with Chinese universities and the Chinese Academy of Science.[48] These firms are now in the position to further entrench their dominance with China's domestic technology industry. This dominance may also extend abroad as securing official support for overseas acquisitions becomes easier.

Altering Investment Flows: Investment decisions within the industries targeted by China's technology campaign can become fundamentally distorted. The effect of the flood of support and resources into an industry is often rapid growth that is unsustainable in the long run. Low financing costs and cheap land mean than financial constraints become less binding and companies are able to invest in research and expansion projects that would normally not be cost-effective. Government-induced demand also encourages the growth of industries above and beyond what is required by the market. The prospect of rapid growth and government incentives attract many new companies to enter an industry, often irrespective of whether the field is already crowded. The problem is further compounded by the competition between Chinese local governments to promote the industry in their localities. As a result, more resources are pumped into an industry that may already be over-stimulated.

Creating Boom and Bust Cycles: This pattern has played out in several industries in China in the recent past, particularly in the wind and solar industries. Many factors can lead to the end of a government-induced boom. Sometimes an industry grows so rapidly that it outstrips what can be sustained, even with government support. In other instances, the removal of government support can trigger a downcycle in a stimulated industry. During the downcycle, there is often a wave of financial stress among companies as the industry returns to more rational levels. Some companies will go bankrupt and exit an industry altogether. Others will survive through restructuring, often with government support, and emerge as viable players in a newly reformed industry. The process may be tumultuous, but the end result can match the goal of developing an industry and domestic champions within that industry.

CASE STUDY

Government Promotion of the Solar Industry

In the mid-2000s, the Chinese solar industry was a relatively small share of the global market and was not at the forefront of technological advances. Less than 10 years later, this situation had changed dramatically with China dominating the global solar market in terms of production, installation, and, increasingly, innovation. China's solar boom was orchestrated by the Chinese government and led by a mix of both state-owned and private enterprises. In a precursor to many of the methods being utilized in the current technology campaign, the Chinese government identified the solar industry as a strategic growth area and directed government subsidies, domestic procurement preferences, funding from state financial institutions, and directed-investment via state investment funds toward the industry.

As a result of this support, the Chinese solar industry experienced a boom. China's share of global photovoltaic cells increased from 4% of global production in 2004 to more than 70% in 2012.[52] The country also became the largest market for installation of new solar capacity, cementing China's role as both the dominant producer and consumer in the solar market. A group of Chinese solar panel manufacturers emerged as global industry leaders, including Jinko Solar, Suntech Power, Yingli Green Energy, Trina Solar, and LDK Solar.[53] Suntech is indicative of the close connection of many of these companies with the government. Its founder and former chairman described the company as a "seed" of the Communist Party of Wuxi, a booming city located near Shanghai.[54]

The Chinese solar industry began to veer off course in the early 2010s as financial support led to overproduction and a glut of solar panels. Prices fell precipitously and pushed several domestic firms into financial distress. Many of China's domestic champions, including Suntech, were forced into reorganization and received government bailouts. The impact of China's policies was felt far beyond its shores as falling global prices led to bankruptcies among foreign producers. The bankruptcy of Solyndra in the U.S. is commonly attributed to pressure from China. In the aftermath of the glut, the Chinese government has implemented changes to its subsidy policies and targeted cuts in new capacity installation in regions facing overcapacity.[55] Other countries, including the U.S., have imposed tariffs on Chinese solar panels to combat alleged unfair trade practices.

Despite the tumultuous development of the solar sector, China's leading role is now well established. Six of the world's largest solar panel manufacturers are now Chinese.[56] Moreover, Chinese solar firms are increasingly recognized as sources of innovation, rather than merely low-cost producers.[57]

China's current technology campaign has the potential to instigate this type of boom-and-bust cycle in many of the strategic industries being targeted. Semiconductors, robotics, aerial drones, electric vehicles, and AI are among the many sectors experiencing a vast influx of resources and growing rapidly. The risk-return profile of investments in the industry is being fundamentally altered by government intervention. As new firms enter to take advantage of the boom, competition may squeeze profit margins down to unsustainable levels. These sectors may continue to grow rapidly for many years, but a bust will remain a significant risk as long as they are receiving artificial stimulation.

Influencing Global Markets: During the growth cycle, overseas firms competing with Chinese companies in industries targeted by the technology campaign will face significant pressure. Foreign firms will have higher financing and operating costs and may lose market share to Chinese competitors. This can easily lead to backlash against China in countries where domestic firms are being adversely impacted by the campaign. The negative reaction to the Made in China 2025 plan by many policymakers in the U.S. and Europe is an example of this phenomenon. After the bust, the industry may return to a more sustainable footing and many of the Chinese firms receiving government support will have failed. There are, however, likely to be at least some surviving Chinese firms who emerge through the turmoil as viable competitors. Industries targeted by China's technology campaign can therefore be profoundly transformed, even if many of the Chinese firms involved ultimately do not survive.

Conclusion

China's campaign to develop its domestic technology base in order to move up the economic value chain and reduce its reliance on foreign technology is now well underway. This effort builds upon initiatives of the past, but the methods being utilized reflect an evolution of the government's approach to the private sector. State capital is being augmented by private funding, and both state-owned and private companies are benefiting from government support.

There are inherent limitations to the ability of government policies and programs to achieve technological breakthroughs and develop advanced industries. Nonetheless, China's hybrid approach of embracing both public and private forces for the campaign has the potential to be much more effective than previous efforts. China's large and dynamic private sector has already produced many innovative and cutting-edge firms. As resources and support from the campaign pour in, firms in many industries will be sent into overdrive. This stimulus may ultimately result in significant amounts of irrational and wasted investment, but it will nonetheless have a major impact on global markets for years to come. When the dust settles, China may be left with strong national champions across many of the industries of the future.

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Glossary

Belt and Road Initiative: an international program to spur investment and trade links between China, central Asia, and Europe. The initiative was announced by China's President Xi Jinping in 2013. The official name for the initiative is the "Silk Road Economic Belt and the 21st Century Maritime Silk Road."

Chinese State Council: the chief administrative authority of the People's Republic of China. The State Council is chaired by the premier and includes the heads of each of the cabinet-level executive departments.

Financial Technology (Fintech): new technology and innovation that aims to improve the delivery of financial services. Fintech includes a variety of innovations across personal and commercial finance, including mobile banking, investment and lending services, blockchain technology, and financial literacy and education.

Gross Domestic Product (GDP): a macroeconomic measure of the value of a country's economic output. GDP includes only those goods and services produced domestically; it excludes goods and services produced abroad, even if such goods and services are produced by factors of production (i.e. companies) owned by the country in question.

Internet of Things (IoT): the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and connectivity that enables these things to connect, collect and exchange data. IoT involves extending internet connectivity beyond standard devices, such as desktops, laptops, smartphones and tablets, to a range of traditionally non-internet-enabled physical devices and everyday objects. Embedded with technology, these devices can communicate and interact over the internet, and they can be remotely monitored and controlled.

Middle Income Trap: a typical feature of many emerging markets. Such countries initially manage to improve average income per capita, but due to declining returns to scale, development is often arrested at a middling level, before incomes reach thresholds associated with richer, developed nations.

New Energy Vehicles: plug-in electric vehicles. New energy vehicles include battery electric vehicles and plug-in hybrid electric vehicles.

Patent Cooperation Treaty (PCT): an international patent law treaty that provides a unified procedure for filing patent applications in each of its contracting states. By filing one international patent application under the PCT, applicants can simultaneously seek protection for an invention in a large number of countries.

Policy Banks: three banks in China (Agricultural Development Bank of China, China Development Bank, and Export-Import Bank of China) that were established in 1994 to finance state-invested projects, as well as economic and trade development priorities.

Public-Private Partnership: a government service or private business venture that is funded and operated through a partnership of government and one or more private sector companies.

Renminbi (RMB): the official currency of the People's Republic of China. The name literally means "people's currency." The yuan (sign: ¥) is the basic unit of the renminbi, but is also used to refer to the Chinese currency generally, especially in international contexts.

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