Asia Business Council

Shenzhen, Beijing, and Silicon Valley: Chinese and U.S. Technology Clusters Vie for Supremacy

Asia Business Council

September 2018

Shenzhen, Beijing, and Silicon Valley: Chinese and U.S. Technology Clusters Vie for Supremacy

By Janet Pau, Jill Baker, and Nina Houston

EXECUTIVE SUMMARY

We live in an age of great technological change. The proliferation of connected and converging technologies is changing not only daily routines, but also shaping the future of nations at a strategic level and, especially in China, at the level of urban planning. Increasingly, the competitive advantages of nations rise and fall on their ability to turn technological innovation into a new engine of economic growth. Nowhere is this taking place more radically or profoundly than in China—which is in the midst of a technological innovation push, driven both by government policies and business activity. This briefing examines three distinct technology clusters, which are geographic concentrations of interconnected companies and institutions involved in technological innovation, in China and the U.S. It explores common success factors that have enabled the clusters to grow so far, as well as the challenges the clusters must overcome to move to the next level of development and generate high-quality growth.

The three clusters of focus are the Greater Bay Area in China's Pearl River Delta, Silicon Valley in the United States, and the Beijing-Tianjin-Hebei region, known as Jing-Jin-Ji. While the U.S.'s Silicon Valley is an established innovation hub firmly rooted in a market-oriented economy, China's Greater Bay Area and Jing-Jin-Ji are examples of technological innovation with Chinese characteristics, aspiring to rival Silicon Valley. The Greater Bay Area is leveraging the complementary strength of Shenzhen, Hong Kong, and surrounding cities, and evolving rapidly from a global export and manufacturing hub into one of the world's premiere technology clusters. Top-down support from the Chinese government is expected to further help integrate the cities in the region in terms of infrastructure and certain regulations. The Jing-Jin-Ji region region is also an area of intense technological investments, with Beijing particularly focusing on artificial intelligence (AI).

At a company level, Chinese technology giants are opening R&D centers in Silicon Valley, to gain location-specific advantages.[1] At the same time, U.S. technology giants are trying to enter China to tap into the skills of the fast-growing science, technology, engineering, and mathematics (STEM) workforce, as well as the wallet share of the world's largest online population. This briefing explores how these three

technology clusters are competing for human and economic capital, and seeking to benefit from populations of vibrant young workers and the economic vitality that new technology businesses bring.

The briefing is divided into three parts. Part I describes the brief history of each technology cluster's emergence. Part II identifies the common underlying success factors for technology clusters and compares the three areas in terms of their approach to and performance on each factor. Part III analyzes the key common challenges that technology clusters have to resolve in the longer term, in order to move to the next level of development, not merely growing their own companies' scale, but contributing to a greater common good.

FIGURE 1
BASIC SUCCESS FACTORS AND NEXT-LEVEL REQUIREMENTS FOR TECHNOLOGY CLUSTERS

INTRODUCTION

China, having excelled in becoming the factory of the world, is approaching middle income levels and showing signs of slowing growth. Excess industrial capacity and declining investment returns in pockets of the centrally-planned economy, pollution from resource-intensive manufacturing, excessive leverage at the regional level, rising manufacturing costs, and an aging population have made economic rebalancing an imperative. To make the transition to an advanced nation, China is now prioritizing the upgrading of Chinese industry.

This upgrading is happening due to both corporate and government efforts. Embodied in China's 13th Five-Year Plan and outlined more explicitly in Made in China 2025, China's industrial policy is targeted at upgrading strategic sectors by 2025, particularly through increasing the share of domestic content in these sectors. The plan aims to bootstrap economic growth and renewal, and the government is expending significant financial and policy resources to achieve this aim.

China is showing strong progress toward its goals. The list of the world's most valuable companies, which a decade ago was dominated by the oil and gas sector, is now topped by technology companies—namely Apple, Amazon, Alphabet, Microsoft, and Facebook. Closely following are Chinese technology giants Alibaba and Tencent, which just five years ago were nowhere on the list. They are also first and second on China's Ministry of Industry and Informational Technology's list of top 100 Chinese Internet companies, with Baidu, JD.com and NetEase making up the remainder of the top five.[2] Including non-public companies, the world's top 20 technology giants all hail from either the U.S. or China.[3]

This briefing looks at a region that is quickly becoming a center of excellence for Chinese industrial upgrading—the Greater Bay Area in the Pearl River Delta region. Known as the Silicon Valley of Hardware, Shenzhen, which is at the epicenter, is expected to generate innovations in products and processes that will have the potential to transform Chinese industries. Shenzhen is also home to China's

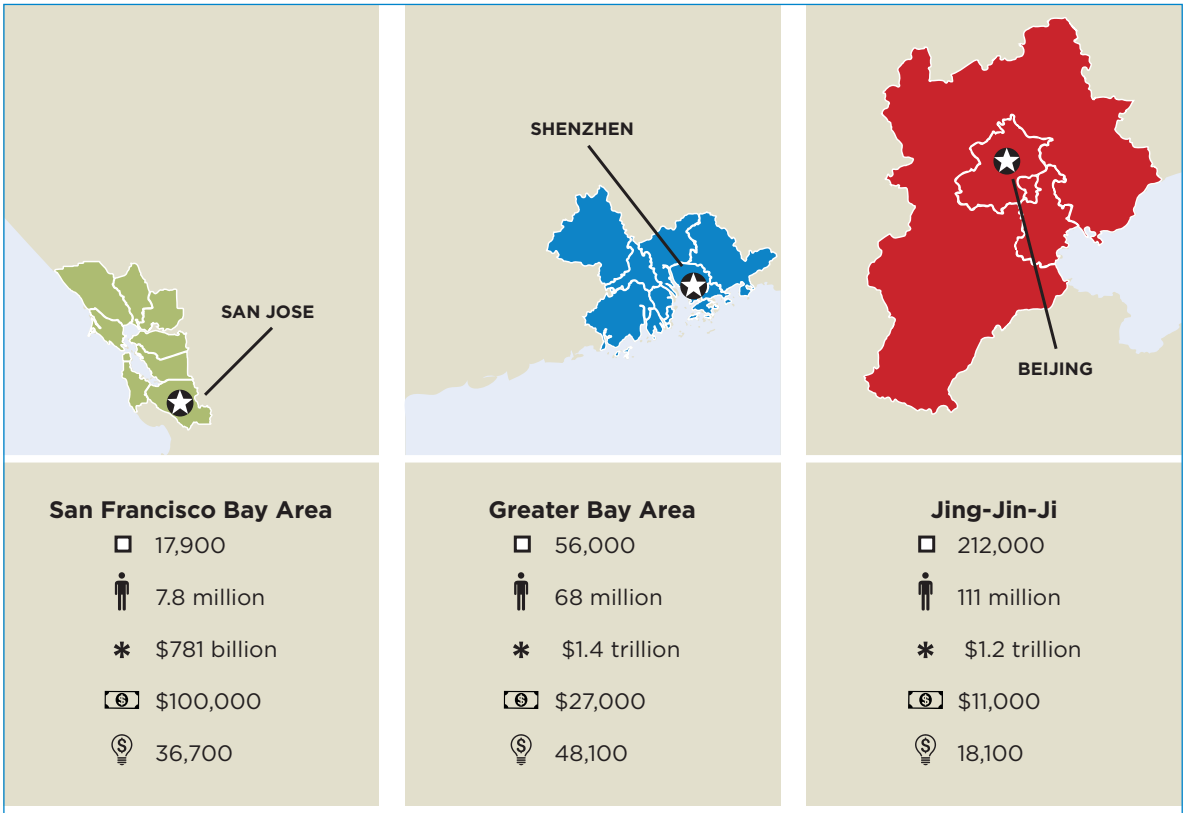

FIGURE 2
OVERVIEW OF THREE TECHNOLOGY CLUSTERS IN CHINA AND THE U.S.

"maker movement," where creative entrepreneurs put together hardware and electronics and share information using open source hardware and software—a very different model than the closely guarded models in the West. This region is compared and contrasted with the original Silicon Valley in the San Francisco Bay Area. Jing-Jin-Ji is also added for comparison, to showcase the multidisciplinary efforts of technological upgrading by business, government, universities, and research institutions.

PART I: BRIEF HISTORY OF THE EMERGENCE OF THE THREE TECHNOLOGY CLUSTERS

CHINA'S GREATER BAY AREA

With Shenzhen and Hong Kong at its core, the Pearl River Delta has long been the most open and market-oriented part of China. The Greater Bay Area initiative, unveiled by China's Premier Li Keqiang in March 2017 and in July 2017 signed by the National Development and Reform Commission (NDRC) and the governments of Guangdong, Hong Kong, and Macau, aims to further integrate Hong Kong and Macau with the nine major cities of Guangdong's Pearl River Delta. The Greater Bay Area is forecast to become the world's largest bay area economy by 2030, with a GDP of $4.62 trillion.[4]

While details for this ambitious urban integration initiative are yet to be unveiled, improving the level of cooperation and coordination within the region will undoubtedly help cities complement each other better in terms of ease of doing business. Hong Kong's financial and professional services sectors, intellectual property laws and legal system make it uniquely positioned to be not only the gateway between China and the world, but an international center for fundraising and dispute resolution. Shenzhen's advantage is its high-tech manufacturing and R&D-driven innovation. Major technology companies including DJI, Huawei, and Tencent are based in Shenzhen, and Apple has set up an R&D center there. Dongguan and Guangzhou have built up world-class manufacturing capabilities over the past few decades.[5] The Greater Bay Area's new infrastructure, including high-speed rail links and the world's longest sea bridge, with border crossings potentially to be enhanced with facial recognition, will help stitch the region more closely together. Currently, cities in the Greater Bay Area still fall under different customs zones, and much economic, legal and regulatory harmonization is required.

	San Francisco Bay Area	Greater Bay Area	Jing-Jin-Ji
Top technology companies by market capitalization (US$) and key players (as of September 18, 2018)	Apple: $1,050 billion Amazon: $945 billion Alphabet: $814 billion Facebook: $463 billion Tesla: $285 billion Intel: $213 billion Netflix: $157 billion	Tencent: $397 billion BYD: $18.4 billion ZTE: $10.6 billion TCL Corp: $5.4 billion Huawei: private	Baidu: $75.8 billion Xiaomi: $46.8 billion JD: $37.2 billion Lenovo: $8.3 billion
Number of unicorns valued at more than $1 billion (as of September 7, 2018) and sample unicorn companies	Silicon Valley: 57 Airbnb (hospitality) Lyft (transportation) Palantir (software) Sofi (fintech) SpaceX (space craft) Uber (transportation)	Shenzhen: 12 DJI (drones) iCarbonX (biotech) Jubaohui (fintech) Royole (smart hardware) WeBank (fintech) UBtech Robotics (AI & robotics)	Beijing: 65 ByteDance (media & entertainment) Didi Chuxing (transportation) Jiedaibao (fintech) Lianjia (real estate) Meituan-Dianping (consumer)

Sources: China Money Network, The Economist, Crunchbase, Bloomberg

FIGURE 3
REPRESENTATIVE COMPANIES IN THE THREE TECHNOLOGY CLUSTERS

Taxes on salaries, for example, currently vary between Hong Kong's effective maximum of 15% and the mainland's 45%.

SAN FRANCISCO BAY AREA

Silicon Valley, in the San Francisco Bay Area, is home to the world's deepest and wealthiest technology cluster. Shaped by the forces of education, government-funded research, war, and the drive for newness, it has evolved from a sleepy agriculture and maritime-focused economy into an area whose name is synonymous with innovation at the end of the 20th century.[6]

Silicon Valley's early success can be traced, in large part, to synergies between its local electronics industry (radio and microwave technologies), the military, and major research universities in the area.[7] The original cyclotron or atom smasher, built by Ernest Lawrence at the University of California, Berkeley and for which he won a Nobel Prize in 1939, used an 80-ton magnet donated to Berkeley by the Federal Telegraph Company, an innovator in radio and a key supplier to the military in World War I.[8] Later Berkeley's particle physics research formed the basis for and provided manpower in the form of Robert Oppenheimer and others to the Los Alamos based Manhattan Project.[9] Stanford University has played an important role as nexus for R&D and corporate cross-pollination, founding institutions like the Stanford Industrial Park (now Stanford Research Park), where high-tech firms like Hewlett-Packard, Eastman Kodak, General Electric and Lockheed Corporation located. The Stanford Research Institute, known as SRI today, is responsible for much of the functionality of today's smartphone, thanks to research on behalf of the U.S. government-funded Defense Advanced Research Products Agency (DARPA).[10] Xerox, drawn by the benefits of being close to Stanford, opened the Palo Alto Research Center or PARC there, which spawned the Alto, the first workstation with a mouse in 1974 and the first GUI (Graphical User Interface) in 1975. In 1976, Xerox PARC deployed the first Ethernet for local and area networks.[11]

Another notable example of synergies between government and business is NASA precursor Ames Aeronautical Laboratory, which the government built at Moffet Field, California, for "urgent research in aircraft structures" at the beginning of World War II.[12] Lockheed moved its Missiles and Space Division immediately adjacent to Moffett Field, and during the Cold War and the space race, was one of the area's largest high-tech employers.[13]

Beyond government funding, Silicon Valley's rise was fueled by venture capital, which staked firms like Intel, Atari, Genentech, and Apple, many of which went public. Between 1995 and 2000, a wave of dot com enthusiasm drove the Nasdaq Composite up 400%. Its subsequent crash, in March of 2000, erased 78% of its peak value.[14] Corporate survivors nonetheless benefited from the tectonic technological shifts leading to products like the iPhone, Android, and Kindle, advances in silicon chips, storage, sensors, and networking, and the beginning of big data and cloud computing. The FAANG stocks (Facebook, Apple, Amazon, Netflix, and Google) are the poster-children for Silicon Valley companies riding the wave of creative disruption. Their stories highlight the role Silicon Valley plays as a technology incubator in the fast-moving digital age.

JING-JIN-JI

Beijing has long benefitted from its status as China's capital and from the presence of China's top universities. It is northern China's center for innovation, and the economic engine of the government plan for Jing-Jin-Ji, which has been in the works for many years and seen accelerated investments in the last several years. Government influence has played a greater role in Jing-Jin-Ji's economic development than in Shenzhen and the cities of the Pearl River Delta, where the private sector has held greater sway. The Jing-Jin-Ji development plan calls for increased economic integration and coordination between and among the municipalities of Beijing and Tianjin and Hebei province, creating an economic

triangle and another new super city cluster, in addition to the megalopolises in the Yangtze River Delta and the Pearl River Delta.

With its technology hub, Zhongguancun, Beijing is already an innovation stronghold. Companies are working at the cutting edge of biomedicine, smart manufacturing, and especially AI. Beijing is home to almost one-third of China's AI companies, and science and technology innovation accounted for nearly 60% of Beijing's 2017 economic growth.[15] As envisaged by the government's blueprint, Tianjin will build on its existing strength as a logistics hub and focus on advanced manufacturing and international shipping. Hebei, traditionally reliant on agriculture and heavy industry, and significantly less wealthy than the other two points of the triangle, will transition away from heavy industry, like steel, iron, and glass, into clean manufacturing and wholesale trading, and offer a relocation zone for light industry currently in Beijing.[16] Tencent announced in August 2018, that it will build a state-of-the-art data facility in Zhangjiakou in Hebei province, which is also one of the main venues for the 2022 Winter Olympics. In April 2018, the Central Committee announced the creation of the future Xiong'an New Area, to be located in Hebei, 60 miles southwest of Beijing. This is part of the government's longer-term plan to move "non-capital" functions out of the city, as well as to locate high-tech industries in Xiong'an.[17] Chinese President Xi Jinping has promoted a number of experienced officials to the region. Xu Qin, mayor of Shenzhen from 2010 to 2017, was parachuted in as the new governor of Hebei, and Chen Gang, a technocrat who oversaw Beijing's high-tech industries, became the first head of the Xiong'an New District.[18] During British Prime Minister Theresa May's visit in February 2018, the U.K. announced that the Canary Wharf Group would help build a fintech hub in Xiong'an.[19] Chinese businesses are being incentivized to relocate to Hebei or Tianjin through the introduction of unified regulations, and attractive social services, eventually to be seamlessly connected by high-speed rail.[20]

PART II: HOW TECHNOLOGICAL INNOVATION CLUSTERS HAVE SUCCEEDED

A number of common factors have consistently emerged as key drivers of the success of technology clusters, including access to talent, government support, sufficient sources of innovation financing from private and public markets, and significant R&D activity and output. The following section provides an overview of these factors and the ways in which each technology cluster has capitalized on them.

TALENT AVAILABILITY

The ability of the technology clusters examined in this briefing to become magnets for talent is crucial to innovation and entrepreneurship. The inflow of talent is driven primarily by two factors—the presence of top universities that supply highly-skilled graduates to the local workforce and generate new entrepreneurs and the ability of clusters to attract talent from other parts of the country and from overseas. In addition, workforce retention strategies affect companies' supply of more experienced talent for continued innovation.

It is no coincidence that Beijing, home to some of China's most prestigious universities and research institutes, has also become a major technology hub. Beijing's Tsinghua University, which counts among its graduates the founders of companies such as Meituan-Dianping, Pony.ai, and Roadstar.ai, has graduated the highest number of start-up founders, numbering 192, in the three years ending 2017. Peking University was not far behind, at 183.[21]

In recent years, Chinese technology companies have also been aggressively attracting top overseas-trained talent to return home. According to a 2017 survey of almost 2,000 overseas Chinese returnees by the Center for China and Globalization, more than 15% joined the technology sector, surpassing finance for the first time. Technology companies not only offer financial incentives but advancement opportunities; given the 830 million-strong Internet user base, technology talent has loads of data to use for honing their AI models.[22]

Shenzhen's workforce has benefited greatly from talent migration from other parts of China. Only 30% of the city's population officially has *hukou* (residence permit) there, qualifying Shenzhen as China's largest immigrant city and illustrating its allure for young, aspiring talent. The city's population has grown more than any other city since 1980, from roughly 30,000 inhabitants to its current nearly 13 million, and its level of college-educated talent stood at 37% of its population, higher than a comparable 29% for Beijing.[23]

In Silicon Valley, the workforce is both more educated and far more international than that in the U.S. as a whole. Almost half of the general population has at least an undergraduate degree, compared with 28% for the U.S. overall. Nearly 20% hold a graduate or professional degree. More than 60% of the college graduates working in science and engineering fields in Silicon Valley were born overseas, very high when compared to the roughly 15% for the U.S. overall.[24] This diversity has led to a remarkable cross-pollination of ideas.

The U.S. owes much of its success in start-ups and entrepreneurship to the ingenuity and creativity of immigrant entrepreneurs who choose to build and grow their businesses in the U.S. According to the National Venture Capital Association (NVCA), venture-backed companies with at least one immigrant founder include iconic American brands like eBay, Facebook, Google, Intel, LinkedIn, Zipcar, and Tesla Motors. A 2016 NVCA study found that immigrants have started more than half of America's start-up companies valued at $1 billion or more and hold key management or product development roles in over 70% of them.[25]

Attracting and retaining good employees hinges in large part on compensation. Start-ups in Silicon Valley face serious challenges for talent from established players like Facebook, where the median salary is more than $200,000 and stock options add upside. Start-ups are able to compete by giving employees equity, and the prospect of an initial public offering (IPO). Among the big companies, competition to retain talent extends to employee benefits (Facebook recently introduced unlimited vacations). Employee perks have gone beyond on-site gyms and ping-pong tables to include paid parental leave, fertility services such as egg-freezing, and additional benefits such as "baby cash" for employees who are new parents.[26]

Large technology companies in China have come also up with programs to retain and upgrade talent. They offer competitive wages, in some cases putting their employees' salaries in striking range of those of their Silicon Valley peers, despite cost-of-living differentials between China and the U.S. Publicly traded technology companies offer stock options, and a range of other employee benefits, including training geared toward millennial employees. Tencent uses a mobile learning platform called Q-Learning to generate creative and engaging training content for employees, in order to provide enjoyable learning opportunities for the high-potential talent. Baidu and Tencent are both reportedly leaders in "smart HR" for employee retention. Techniques include using employee data from social media platforms, email and chats, to identify workers likely to leave.[27] Unlike in the U.S., few of China's tech workers are foreign-born and this reliance on homegrown talent is likely to persist. Still, China is working harder to attract global technology workers. China announced that foreign hires and their families will enjoy greater freedom of cross-border travel and benefits such as enrolling in local schools and more liberal rules for bringing in domestic helpers. Foreign scientists with permanent residency status now can lead national-level innovation projects, where such leadership positions previously were reserved for Chinese nationals. While the number of applications is currently still small, these policies allow China to take advantage of skilled talent from abroad.[28]

GOVERNMENT SUPPORT

Whether it is through providing funding, offering attractive R&D tax benefits, or ensuring a trusted intellectual property regime, government support has played a key role in every modern technology cluster's success.[29] This section analyzes some of the actions both local and national governments have taken to help their respective clusters gain advantage.

A key part of Silicon Valley's attractiveness is its ability to offer a strong rule of law, including well-established intellectual property laws. The region's legacy as a center of technological research for military communications shows the importance of the government's role in igniting the sector's growth. Academics have characterized the economic relationship between Silicon Valley and the national security community as a hybrid public-private economy, in which the government assists in the creation of new technologies it needs for national security operations by investing in companies that can also commercialize technologies. In-Q-Tel, for example, is an American not-for-profit strategic investor that partners with for-profit venture capital firms and the U.S. intelligence community, including the Central Intelligence Agency (CIA). It invests for the purpose of keeping U.S. intelligence agencies equipped with cutting-edge technological capabilities, which it then allows the private sector to adopt.[30] Google Earth originated in an In-Q-Tel sponsored company called Keyhole Inc., a 3-D mapping start-up partially owned by the government. Recently, the Pentagon moved to strengthen ties with Silicon Valley, and in June 2018 announced the creation of the Joint Artificial Intelligence Center, which will focus on Project Maven, a program designed to develop partnerships with the private sector, including Lockheed Martin and newer Silicon Valley companies, to further develop AI for military applications.[31]

The symbiotic relationship between business and government is also evident in China in the form of policy loans, preferential tax rates, and subsidies of various types from local governments. The Chinese government has a long-held policy of sponsoring national champions in selected industries, companies

which help further the government's strategic aims and in return are granted easier access to financing, given preference in government contract bidding, and sometimes oligarchy or monopoly status in protected industries. Huawei, a current leader in 5G technology, has received numerous contracts and ongoing support from the Chinese government. Another well-documented example is Shenzhen-based BYD, which Warren Buffett owns a stake in through MidAmerican Energy. BYD manufactures traditional and new energy vehicles and rechargeable batteries. Government subsidies have played a significant role in its development, in areas ranging from research and development for electric batteries to "employee stability."[32]

Similar to the importance of Stanford, Berkeley, and other California universities to Silicon Valley, Beijing's universities and, increasingly, its research institutions, play a key role.[33] These efforts are multiplying, thanks to increased backing from the state, as China continues to refine its policy goals and regions define theirs. Beijing plans to build a RMB13.8 billion ($2.1 billion) AI development park in suburban Mentougou district in western Beijing. Zhongguancun Development Group, a high-tech commercialization platform backed by the Beijing government, will oversee it. Announced in early 2018, the new entity will seek to partner with Chinese and overseas universities, research institutes and large companies in a national-level artificial intelligence lab.[34] Also in January, Kai-Fu Lee, the chairman and chief executive of Sinovation Ventures and one of China's most renowned technology experts, was named head of the Beijing Frontier International AI Research Institute. Sinovation will manage one of three innovation centers under the Institute's direction, while SenseTime Co., a machine-learning company, and Powervision Tech Inc., which makes drones, will manage the other two. The NDRC also tapped Beijing-based Baidu, the nation's largest search engine, to lead China's National Engineering Laboratory for Deep Learning Technologies, which was established in March 2017, in conjunction with Tsinghua and Beihang Universities. Baidu will also contribute to the National Engineering Laboratory for Brain-Inspired Intelligence Technology and Applications, established in May 2017, which is working on using AI technologies to develop brain-inspired neural chips and intelligent robotics.[35] Alibaba's cloud company, Aliyun, is partnering with Tsinghua University on the National Engineering Laboratory of Big Data Systems and Software.[36]Tsinghua Holdings, an asset management company run by the university, which incubates, invests, and operates start-up enterprises in a wide range of high-tech industries, demonstrates another aspect of the positive feedback loop between the university and Beijing's start-up ecosystem.[37]

INNOVATION FINANCING

Technology clusters need a strong financial ecosystem. The U.S. has both vibrant venture financing and large equity markets which, along with mergers and acquisitions (M&A), provide exits for venture investors. China's financial ecosystem is growing rapidly, and venture capital is abundant, but exits are more limited. The approval process for IPOs is time-consuming in Shanghai and Shenzhen and the domestic markets are likely to remain stunted for some time. Onerous profitability requirements and a slow approval process have undercut the aspirations of the Shanghai and Shenzhen stock exchanges to list more technology companies. China's most significant technology players have listed outside of the mainland, many of them in the U.S. on the New York or Nasdaq stock exchanges and others in Hong Kong.

Venture capital (VC), which has driven Silicon Valley's startup ecosystem, started in earnest in the U.S. in 1978, raising about $750 million. A cut in the capital gains rate that year, slashing rates from 49.9% to 28%, and legislative changes allowing U.S. pension funds to invest in venture capital, has fueled a funding boom that saw more than $60 billion go into U.S. venture capital last year.[38] Silicon Valley and San Francisco took in $24.9 billion, about 39% of the total U.S. funding share in 2017.

China's growth in venture capital funding has been stunning—it grew 15 times between 2013 and 2017 and accounted for nearly one-quarter of the global total in 2017.[39] Growth has been driven by private firms (including mega-funds like Japan's SoftBank Group), Chinese government-backed funds,

and increasingly, corporate investors. Tencent, Alibaba, and Baidu alone are responsible for close to half of all domestic venture capital investment.[40] Tencent and Alibaba's deals last year included e-commerce and ride-hailing startups in India and Indonesia, which accounted for three of the five biggest venture rounds by Chinese investors in 2017. China-led venture investment outside the country more than doubled in 2017.[41]

Chinese government-backed funds have ambitions to play a big role. China Money Network, an AI-based platform tracking China's venture capital investment trends, calculates that government-linked funds aim to raise nearly $800 billion, equal to over 30% of global VC and private equity assets under management now.[42] While many of these plans won't be realized, state-backed funding is important because it is often directed to strategic areas like semiconductors and AI. China's venture investments in AI totaled some $2.5 billion last year, compared with $4 billion in the U.S.[43] Two big beneficiaries have been Megvii, a Beijing-based unicorn whose technology is used in Alipay's "scan your face to pay" function, and its rival, SenseTime.

Of China's top 10 most active VC firms, seven are in Beijing, followed by Shanghai (two), and Shenzhen (one).[44] In the early 2000s, Shenzhen rolled out regulations to help with the growth and stability of the VC industry, and a group of private equity firms banded together to strengthen laws on investor protection and disclosure. Shenzhen is now home to more than 500 VC firms, a crucial part of the start-up ecosystem, and the Shenzhen stock exchange has opened ChiNext to list small and mid-sized enterprises.[45] The Shenzhen exchange has a larger share of emerging companies than does Shanghai. The development of Shenzhen's Qianhai New District, which is scheduled for completion by 2020, is also expected to boost investment flows as it becomes the city's principal finance, logistics, and IT hub.

All this activity aside, China's stock markets are small relative to the size of its economy. The Shanghai Stock Exchange (SSE) and the Shenzhen Stock Exchange (SZSE) are subject to more intervention by regulators than western markets—notably when IPOs were halted and trading suspended in about 40% of the market capitalization of Shanghai shares during a 2015 market rout. Equity accounts for less than 5% of total corporate fund-raising; bank loans and retained earnings remain by far the biggest sources of capital for Chinese companies. [46]

Hong Kong's fully convertible currency, adherence to international accounting standards, and open stock market make the territory the natural home for Chinese companies to tap international capital markets. Hong Kong Exchanges and Clearing (HKEX), which owns the Stock Exchange of Hong Kong, earlier this year rolled out the biggest change to its listing rules in 25 years to encourage more companies to list. The changes, prompted by the loss of Alibaba's record-breaking 2014 IPO to New York, allow companies to have two classes of shares. Corporate governance advocates don't like the change because it makes dislodging founders harder. (Unlike the U.S., Hong Kong does not allow class action lawsuits, leaving minority shareholders without a key avenue of redress to hold management to account.)[47] HKEX's new listing rules also make it easier for start-ups, especially in technology sectors like biotech, to list on the main board. Hong Kong also has a role in nurturing the mainland's financial opening. HKEX runs one side of the so-called Stock Connect, which allows global investors to access some 1,900 mainland stocks. Mainland investors can buy Hong Kong stocks through this program, which allows China to maintain strict currency controls even as it allows investors on both sides of the border more investment choices.

RESEARCH ACTIVITY

Whether funded and supported by governments, universities, or private enterprises, a commitment to R&D is illustrative of a technology cluster's future capacity to innovate and a core reason for the success behind the world's biggest and most innovative technology companies. The output produced by R&D activity is commonly measured by patents as well as research publications.

Both in the U.S. and China, leading technology companies have been driving R&D spending. Alphabet, in 2017 spent 15% of revenue on R&D, in line with a mid-teens spend rate since 2014, Baidu's R&D expenditure is at the same level. Facebook's R&D expenditures have traditionally been higher, at 20% to 25% of sales in recent years. Alibaba discloses that 45% of its employees are devoted to R&D and its R&D expenses are roughly 6.5% of sales. And Alibaba separately has founded DAMO Academy, pledging $15 billion over the next three years with a focus on AI, IoT, fintech, quantum computing, and human-machine interaction.[48] Tencent discloses its R&D expense at 7% to 8% of revenue for the past several years.[49]

China is catching up to the U.S. in its R&D capability. It currently ranks second to the U.S. in R&D spending, and its patent activity is accelerating.[50] With over $21.7 billion spent on R&D in Beijing in 2016, the highest of any city in China, Beijing is taking an active lead. [51] Often seen as a proxy for intellectual property rights, patents encourage innovation and create the tools for trading innovation worldwide. The Global Innovation Index (GII) 2018, compiled by Cornell University, INSEAD, and the World Intellectual Property Organization, which measures innovation at a holistic societal level, saw China advance five places, from 22nd to 17th, notably becoming the only middle-income country in the top 20. The U.S. lost ground, falling from fourth to sixth. The U.S. lost ground in human capital and research, infrastructure, and creative output, though it still holds the top rank in many important indicators such as R&D, company expenditures, and quality of universities. China's rise in the index is driven by large improvements in the number of companies engaged in global R&D, the quality of its publications, its patents, and tertiary enrollment.[52]

The GII ranks countries by science and technology clusters, using patent filings and scientific publishing activity as proxies for the agglomerations of science and technology. The index notes that China, though a middle-income country, outperforms the high-income group average in the quality of scientific publications and its universities, reflecting the high scores received by top Chinese universities Tsinghua, Peking, and Fudan this year. The Tokyo-Yokohama cluster leads, followed by the Shenzhen-Hong Kong cluster, followed by Seoul, with Silicon Valley and Beijing ranked fourth and fifth respectively. China's large number of science and engineering university students give the country a unique advantage in AI development. About 40% of the leading AI research papers in the world are published by Chinese authors. Although the top-level experts are still North American, the Chinese are catching up quickly.[53]

In Shenzhen, more than 90% of the R&D spending originates from private enterprises rather than the government. It runs double that of the mainland average, at 4.7% of the city's GDP. [54] The number of patents coming out of Shenzhen comprised 52% of China's total number of patent applications through June of 2016 and through the first half of 2017, according to a tally by the Cheung Kong Graduate School of Business.[55] Huawei, for example, has over 45% of its workforce working in R&D, with RMB394 billion spent on R&D during the past decade.[56] DJI, now the world's largest commercial drone maker (valued at roughly $15 billion), has 40% of its workforce working in R&D.[57] This level of R&D spending among companies such as DJI and Huawei has been a major factor in their success and ability to grow quickly.

From being known as a manufacturing center in the 1980s, and in the early 2000s a source for "shanzhai," or cheap knock-off products, Shenzhen continues to evolve. Makers from China and around the world still flock there to find components and fabricate prototypes that can be manufactured at scale and go to market quickly. DJI, founded in Hong Kong, grew rapidly in Shenzhen. DJI itself highlights the ability of Shenzhen to provide direct access to suppliers, raw materials, and young talent, all of which enable rapid materialization of ideas into real products.[58] Building on its expertise with prototyping and assembly, Shenzhen has become a locus for makers of a different kind: hackers (in the sense of skilled computer experts), coders, and hardware start-ups, leading to the city's rise as a technology hub. Today, one of its most prominent examples is Tencent's messaging app Weixin (and WeChat, a

version of Weixin for users who register with a non-Chinese cell number). Weixin "is like is Facebook, WhatsApp, Tinder, PayPal and Slack combined," says Edith Yeung, head of 500 Start-ups Greater China. Roughly 80% of China's Internet users are active on WeChat—spending on average 66 minutes a day on the platform, doing everything from hailing taxis to paying their phone bill.[59]

Unlike Beijing, academic and research institutions played a relatively small role in Shenzhen's initial development into a technology hub; though the city has been working to attract such institutions in recent years. In a bid to catch up, Shenzhen has established the Research Institute of Tsinghua University in Shenzhen, the Peking University-Hong Kong University of Science and Technology Shenzhen-Hong Kong Institution, the Shenzhen Virtual University Park, and other research organizations.[60]

PART III: BRINGING TECHNOLOGY CLUSTERS TO THE NEXT LEVEL

Having built scale quickly, technology clusters must now drive for quality growth. Despite the promise of technological innovation and convergence, the respective future growth trajectories of technology clusters and the societal impact of their growth are far from clear. The many hurdles that technology clusters face range from an increasing talent-and-income divide, driven by the unequal distribution of rewards resulting from the shift to an increasingly digital economy; asset price inflation in wages and living costs; and environmental degradation resulting from growth. Last but not least, technology clusters face critical choices as the market dominance of large incumbent players risks crowding out smaller players and stifling innovation and entrepreneurship. As these companies seek to expand beyond their home markets, their choices regarding regulatory standards, including intellectual property protection and data privacy, will affect their growth trajectory and shape the future of the markets in which they operate. These challenges, if unresolved, directly hurt the sustainability of technology clusters' growth and erode the advantages that have enabled them to succeed. Successfully overcoming these challenges would help move technology clusters to the next level, with increased productivity ultimately translating into a greater common good: specifically, more widespread prosperity and an increased standard of living for all.

BRIDGING TALENT-AND-INCOME DIVIDE

The positives of technology-led industries, or Industry 4.0, also come with a downside—the talent-and-income divide, which describes a growing gap between those who are able to benefit from a technology-driven economy and those who are not. In Silicon Valley the gap in median income between workers with the highest and lowest educational attainment is close to $88,000 with the highest-educated earning about 4.4 times more than the lowest.[61] The resulting socioeconomic divide could lead to political backlash against the technology elites and also skilled immigrant workers. The growing prevalence of AI and automation also reduces the share of human labor required, especially to perform tasks that are of a routine and predictable nature. The challenge for technology clusters is to address this widening chasm before it becomes a larger problem.[62]

Resolving the unequal sharing of the economic pie and the resulting social disaffection might require policies to ensure that the economic prosperity generated from a technology-driven economy can be shared more broadly. One priority is re-tooling education and labor policies to reskill workers for the evolving job landscape and matching workers with jobs. Despite its per capita wealth, Silicon Valley's public schools fail to adequately prepare students for productive careers. According to a 2017 Silicon Valley Competitiveness and Innovation Project report, more than half of the 11th grade student population failed to meet state standards in math, and just over one-third failed to meet them in English language arts. Students who are left behind risk becoming disaffected future citizens.[63]

China, which has long depended on raw labor power, faces this talent-and-income divide as it seeks to upgrade many of its traditionally labor-intensive industries. In 2016, World Bank president Jim Yong Kim warned that as many as 77% of China's jobs could be eliminated by automation.[64] Kai-Fu Lee stresses this point, saying that framing AI technology development in China and the U.S. as an arms race is narrow-minded.[65] Instead, he sees both the U.S. and China as winners in the long term, with the benefits of AI accruing to them. But the many displaced workers will be losers. One idea put forth is for China and the U.S. to tax their national digital champions to subsidize welfare for those whose jobs have been eliminated by technology. Other countries, he suggests, may have to bargain with the U.S. and China to obtain some form of welfare for their people in exchange for U.S. and Chinese companies making profits from their citizens.[66] China's Ministry of Industry and Information Technology has released a national AI development plan that acknowledges the risk inherent in an AI-driven economy, including job losses. The plan promises to invest in education that emphasizes a shift in focus to a learner-centric education environment, incorporates STEM subjects at the elementary and secondary

levels, employs big data and online learning platforms, and includes skills training that aligns workers with the job market.[67] The *China Internet Report* 2018 highlighted that large technology companies have live-streamed education programs for 55 million rural children—potentially providing a model for how technology companies can contribute to bridging technical skill gaps in the longer term.[68] Although the results of this long-term plan are yet to be seen, there is no doubt that improving the overall workforce's data literacy and bolstering skills training are necessary to bridge the risk of a greater talent-and-income divide as China grows its technology-driven sectors.

Beyond skills training and education, policies that aim to expand the social safety net, specifically targeted at technology clusters, have also gained traction, particularly in Silicon Valley. Congressman Ro Khanna, who represents California's 17th congressional district, encompassing cities in Santa Clara and Alameda counties where Apple and Intel are headquartered, is working to address the skills gap and the income divide Industry 4.0 will exacerbate. He supports higher taxes on the wealthy, and an increase in the Earned Income Tax Credit, which would supplement the wages of low-income earners by as much as $10,000 per year. Khanna also favors universal healthcare. [69] Other economies, from Finland to India, have done experiments on implementing a universal basic income for citizens in various forms. Y Combinator, a technology incubator in Silicon Valley, is planning to launch a 2019 study giving a group of Americans a basic income for five years, in the hopes of motivating people to work and be productive once basic needs are met.[70]

Around the world, a so-called "gig economy" is emerging as an alternative to traditional and continuous employment. But these workers lack the traditional safety net, like health benefits, accorded those with full-time employment. Changing insurance policies to allow more workers to partake in part-time, temporary, or contracting work, will help with the future transitions of the job landscape.

IMPROVING AFFORDABILITY AND QUALITY OF LIFE

The growth of technology clusters has increased wealth and, in some cases, generated outsized economic gains for technology elites and highly educated and skilled talent, but skyrocketing property prices, rents, and cost of living are plaguing all three of these technology clusters. Shenzhen saw property prices rise 60% in the first quarter of 2016; land prices in Beijing skyrocketed 1,536 % from 2004 to 2016; Hong Kong home prices rose 364% during the period from 2003 to 2017. [71] In Silicon Valley, home prices in the last five years have climbed 50%.[72] Housing cost inflation not only diminishes the regions' affordability for new and existing talent who want to work at technology firms there, but also widens socioeconomic inequalities for existing residents who are not working in the sector.

In Silicon Valley, a shortage of housing units is a chronic problem, one that has also pushed up rent and property prices. The median home in the San Francisco Bay Area is $940,000, roughly 4.5 times the U.S. national average.[73] Too few houses for sale has exacerbated the problem. This is in part due to California's Proposition 13, passed in 1978, which allows for only slight annual increases in property tax rates for existing owners after purchase of a home, and, in turn, led to decreased turnover.[74] The shortage is also due in part to zoning regulations that make it difficult for developers to build near public transit, and neighborhood residents who do not want more development in their backyards.[75] Some technology companies have even offered new employees $10,000 to "de-locate" from the Bay Area in an effort to drive down their living costs.[76] Without building new units, or creating greater incentives for owners to sell, these problems will persist. A 2018 poll by the Bay Area Council showed that 46% of residents are ready to leave in the next few years, up from 40% last year and 36% two years ago. Fifty-two percent of millennials feel this way, up from 46% in 2016.[77] These challenges are not just affecting residents but businesses as well, as commercial rents go up and labor becomes costlier.

Silicon Valley is not alone in facing these challenges. Shenzhen has long relied on informal settlements, or so-called "urban villages," like Baishizhou and Qinghu (home to many Foxconn workers) to

provide affordable rental housing to its workers. The dwellings, largely consisting of concrete blocks built so close together that they are known as "handshake buildings," now house roughly half of Shenzhen's population, but are under threat of re-development.[78] The 2018 College Graduates' Employment report found that in 2017 almost one-quarter of recent college graduates chose to leave first-tier cities—Beijing and Shenzhen among them—after three years of employment, in favor of second-tier cities, an increase of 8% when compared to 2015. The young workers reported they were turned off by crowdedness, traffic congestion, smog, surging property prices, and difficulty in obtaining permanent residency in the first-tier cities. Second-tier cities have stepped up, offering sweeteners like preferential treatment to obtain *hukou*, and housing and government subsidies, to attract recent graduates.[79]

Across technology clusters, a range of public and private sector solutions has emerged to tackle housing cost inflation, to help maintain attractiveness for skilled talent and improve affordability for a broader set of people. In Silicon Valley, Facebook has proposed building 1,500 housing units, of which 15% will be designated affordable housing, adjacent to its Menlo Park headquarters. Google plans to build 9,850 housing units near its headquarters in Mountain View to offer more affordable housing to its 20,000 employees based there.[80] Google is also reportedly in talks with several modular housing makers, including Katerra, which itself raised $865 million from SoftBank, about a proposal to build another 10,000 units of pre-fabricated employee housing.[81] At the state level, California Governor Jerry Brown signed several bills into law in 2017 that were geared toward providing funding and zoning for more affordable housing.[82] Some of the most radical changes to the current real estate landscape are up for a vote in November 2018. The first measure, Proposition 10, would allow cities and counties to have authority over enacting rent control policies on residential properties, allowing buildings built after February 1995 to be subject to rent control. The second measure, Proposition 5, the Property Tax Transfer Initiative, would allow homebuyers over the age of 55 to transfer their current tax rates to a new house, thus encouraging empty nesters to move from houses they have outgrown, increasing housing turnover.[83]

In the Chinese technology clusters, Tencent now offers interest-free loans, ranging between $36,300 and $72,600, for employees buying property in Shenzhen. And Alibaba, though not in one of the clusters discussed, is building 380 apartments on its Hangzhou campus and holding a lottery for employees to be able to purchase an apartment at a steep discount.[84] In Beijing, electronics maker Xiaomi has partnered with China Vanke, the country's largest real estate developer, to develop apartments and offer them to employees below market value.[85]

During China's 19th Party Congress in 2017, President Xi Jinping raised a possible, though controversial, solution to curbing real estate speculation, particularly in first-tier cities. He announced that there would be a shift in China's housing model to focus more on renting over buying properties to help combat ever-growing property prices in major cities and the growing inequalities this has helped foster. In line with this new policy, approximately 30% of Beijing's incremental housing units built will be rental units, by 2021.[86] The jury is out as to how this rental initiative will be received, given that it depresses land values. It does offer cheaper housing solutions at the margin, but by the same token, it reduces the availability of real estate ownership as a long-term investment. Shenzhen, responding to Xi's call for houses "that are for living in, not speculation," in 2017 capped the number of new private homes, announcing that only 40% of the 1.7 million new apartments expected to be built by 2035 can be private. *Reuters* reports that, in a national first, state lenders started giving ultra-low interest rate loans with long repayment periods to renters in Shenzhen.[87] In July 2018, Shenzhen announced that home owners must wait three years to sell, in an effort to discourage speculators looking for a quick return. Shenzhen also closed a popular loophole by disallowing home purchases by corporations and organizations. The Politburo, in a July 2018 statement, reiterated its stance on firmly curbing rising home prices.[88]

As part of Jing-Jin-Ji, Xiong'an New City is meant to alleviate stress on Beijing's infrastructure, and housing price pressures. A key difference between Xiong'an and other special economic areas like

Shenzhen and Pudong is that there is a ban on real estate trading, imposed by county officials in response to speculators. All housing in Xiong'an will be state-owned and provided to authorized workers and employees at subsidized rates.[89] Tianjin, which is struggling to absorb real-estate over-expansion and which is one of China's most rapidly aging cities, has now offered *hukou*s, usually hard to obtain in big cities, to anyone under 40 with a university degree willing to live and work there. The program has garnered huge interest.[90]

Actions at the local, state or provincial, and national levels in all three technology clusters indicate that governments are taking growing cost, quality-of-life, and inequality challenges in their respective technology clusters more seriously, if slowly. With many of the solutions proposed to resolve some of these challenges so recent, and sometimes experimental, it is difficult to predict their likelihood of success. What is certain is that where they are successful, other clusters will copy them quickly. Businesses are also looking at second-tier cities, such as Chengdu and Wuhan in China and Austin, Pittsburgh, and Nashville in the U.S. The latter three are among 20 announced contenders who have made it through the first round of North American metro areas competing to house Amazon's second headquarters. It is clear from Amazon's request for proposal, in which the company reckons that every dollar it spent in greater Seattle has yielded $1.40 for the city's economy overall, that it endeavors to find a city with many of the characteristics outlined in this briefing, not just a lower-cost location. A "highly educated labor pool is critical and a strong university system is required," according to the request for proposal, which also asks the metro area contenders to detail incentives like tax credits or exemptions, relocation incentives, and other forms of government support.[91]

UPGRADING ENVIRONMENTAL SUSTAINABILITY

Notwithstanding past successes, technology clusters must confront greater environmental challenges on the horizon, as ensuring environmentally sustainable growth and strengthening resilience against environmental vulnerabilities are critical to future success of clusters and to the health of their residents. Richard Walker, an urban geographer at the University of California, Berkeley, laments that the expansion of Silicon Valley's technology sector, and resultant urban sprawl has given rise to environmental stress in the form of water and resource depletion as well as air pollution.[92] The San Francisco Bay Area also faces a host of longer-term climate change-related challenges, including sea-level rise and periods of increased drought. San Francisco's South Bay and Silicon Valley's bay levels are projected to rise 24 to 66 inches over the coming decades, effectively doubling the bay's total area. Flooding is happening now, from East Palo Alto to Sunnyvale, a geography that includes the corporate headquarters of a host of the largest technology companies, including Google, Facebook, and Amazon. Annual losses could run as high as $15 billion if nothing is done. In addition, contaminants generated by computer chip manufacturing in the 1960s and 1970s, notably trichloroethylene (TCE), has led the U.S. Environmental Protection Agency to declare TCE contamination the cause of half of Santa Clara county's 24 Superfund sites, according to an exposé by KQED radio.[93]

The need for climate-resilient infrastructure was reinforced this year as flooding and storm surges wrought destruction across Asia. In early September 2018, Japan was blasted by typhoon Jebi, the most powerful storm in 25 years, which forced the closing of Kansai airport, a major transport hub for Osaka, Kobe, and Kyoto. In mid-September, Typhoon Mangkhut cut a deadly swath across the Philippines, Hong Kong, and southwestern China, causing at least 100 deaths, major flooding, and potentially record insurance claims. The Greater Bay Area's vulnerability to flooding and storm surge is not new, though it has been exacerbated by urbanization, landfills, and the dredging of major rivers. Sea levels in the Pearl River Delta are expected to rise close to four times the global average by 2030, an estimated half a meter for the South China Sea by 2100. Much of the southern Pearl River Delta is just 30cm to 40cm above sea level.[94] As the Greater Bay Area further urbanizes and industrializes, development will accelerate and should force municipal governments and private companies alike to consider how prepared they are

for increased likelihood of extreme weather. In the Jing-Jin-Ji cluster, Xiong'an New District, located in low-lying marshlands, has a history of extreme weather, including both the largest flood in modern Chinese history and extreme drought.[95] It is also terribly polluted, which will make the government's intention to make it a green city more challenging. According to *Caixin*, "the fight against pollution in Xiong'an will be a protracted war."[96] Few sewage systems have been built in the area, and its groundwater is extensively polluted both by human and industrial waste. Baiyangdian Lake, northern China's largest wetland, is at risk. Once known as "the kidneys of northern China," *Caixin* reports the fragile ecosystem has been so heavily polluted by copper smelters, aluminum factories, and household sewage that its water is unsuitable for drinking or even agriculture, and could dry up all together.[97]

The fact that several Greater Bay Area cities have "sponge city" plans, which will not only be able to absorb excess water, but also reuse rain water, to combat water shortages, and that cities are building blue-green infrastructure with large green spaces and narrower streets, suggest that these challenges are being recognized and tackled. Shenzhen, in particular, has done much to improve its investment in sustainability in recent years. The city is home to the largest fleet of electric buses in the world (thanks to the public-private partnership between the municipal government and BYD), helping to cut carbon emissions and reduce smog significantly.[98] The city is also reported to have invested 528.1 billion yuan into its infrastructure, focusing on environmental or water-related projects.[99]

Some technology companies have taken a lead in turning environmental challenges into opportunities, riding on California's strong legacy of environmental activism. San Francisco targets 100% renewable energy use by 2030. Google, Facebook, and Apple are among many Silicon Valley companies and other major corporations, including Asia Business Council members' companies Bloomberg, HSBC, Iron Mountain, McKinsey & Company, and Vodafone, who are members of the RE100 alliance of businesses working to use 100% renewable energy.[100]

FOSTERING FAIR COMPETITION AND DEVELOPING INTERNATIONAL STANDARDS

The winner-take-all nature of technology markets is accelerated by the combination of big data and AI. Technology companies that are able to grow both in their chosen markets and beyond their national borders achieve a kind of market dominance that threatens to crowd out smaller players. As technology clusters progress, questions emerge about whether innovative and entrepreneurial activities are being crowded out by big incumbents, and the role government regulation should play as companies expand at home and beyond their home markets.

Fostering entrepreneurship, and the growth of start-ups, is essential for the health of an economy. Without it, there can be distortions that reduce overall welfare, as dominant players benefit at the expense of the broader public, notes the Brookings Institution's Hamilton Project. It found that in recent years, the U.S. has seen decreased entrepreneurship, as measured by a decline in creation of start-up firms. Experts have pointed to increased industry concentration and crowding out by incumbents as some key causes. These firms earn higher profits than they otherwise would in a competitive market without producing commensurate value for the overall economy, the Hamilton Project notes.[101]

Worldwide, incumbent technology players enjoy enormous profit margins and enviable market share. Facebook's share of the world's social media market, excluding China, is 90%. Facebook and Google control two-thirds of the U.S.'s online advertising revenue. Why this is so likely stems from a range of factors, including winner-take-all characteristics of these businesses and government policies that favor them. AI algorithms create the potential for positive feedback. A model-driven company can learn from its successes and failures in a virtuous circle of continuous improvement. Incumbents' moats are also enhanced by network effects, whereby growth in the number of users on a platform like that of Facebook, Tencent, or Google increases the value of its services. The incremental cost of adding a new service to the platform is spread out over a large user base.

Tencent's Weixin, WeChat, and QQ are the top online social networks in China. At the end of the fourth quarter of 2017, Weixin and WeChat had 989 million monthly active users, and QQ had 783 million. The popular food delivery start-up, Beijing-based unicorn Meituan Dianping (of which Tencent is a 20% owner), and others like it, are beholden to Tencent's digital platform infrastructure for user growth and transactions, as well as cloud services. As with many new entrants, Meituan Dianping pays Tencent for marketing and promotion and cloud services, noting in its IPO prospectus "there are limited choices of cloud services providers in the PRC."

The big players in both China and the U.S. have been acquiring or investing in many of the fast-scaling start-ups for the last several years. YouTube, Instagram, and hundreds of lesser-known start-ups sold out to industry gorillas like Google and Facebook rather than trying to compete with them. The technology giants are formidable competitors and it should come as no surprise to find they are throwing their weight around to maintain market dominance. Google, which processes more than 90% of web searches, for example, was recently fined $2.7 billion by the European Union for search practices that favored its own shopping platform. In May, Tencent introduced a ban on linking to 30 popular competitor company apps, cutting off Beijing-based unicorn ByteDance's subsidiary Douyin, a short video app with powerful editing capabilities that appeals to a young, educated demographic and competes with Tencent's Miaopai.[102] ByteDance and Tencent are engaged in heated legal battles, cited by the *Financial Times* in June as "one of the highest-profile anti-competition disputes to hit the country's tech sector in years."[103]

Authors Viktor Mayer-Schönberger and Thomas Ramge, in a *Foreign Affairs* article, argue that existing regulatory tools, such as anti-trust regulation, fail to address the growing threats of industry concentration among data-driven superstar companies. They suggest that a progressive data-sharing mandate, in which every company above a certain size would have to let other companies in the same market access a subset of its data, would be a potential solution that could foster both market diversity and resilience. The larger a firm's market share, the more of its data others would be allowed to see. Data would be stripped of personal identifiers, augmented with metadata to make clear what sort of information the data provided and where it came from, and selected randomly to prevent companies from gaming the system (by granting access only to largely useless data, for instance). Both the European Commission and members of the European Parliament are studying how to legislate progressive data-sharing mandates.[104]

The role that governments play, in the name of fostering national champions, in China's case, or in protecting national security or intellectual property, in the case of the U.S., can allow companies to flourish behind protectionist barriers, but it also adds a layer of complexity and political risk. Under the Trump administration, the U.S. has been more aggressive in using its Committee on Foreign Investment in the United States (CFIUS) to block deals where China is concerned, including Ant Financial's proposed takeover of Moneygram and Broadcom's $117 billion bid for Qualcomm.[105] The U.S. plans heightened scrutiny of foreign investments into American companies, through proposed legislation known as the Foreign Investment Risk Review Modernization Act (FIRRMA), versions of which have passed both the House and Senate. The legislation would extend CFIUS's reach, to include Chinese investment in technology licensing agreements, intellectual property sharing arrangements, open-source collaboration, joint ventures, and technology transfers and investments, including venture capital for start-ups, on national security grounds. This could prove a hindrance to Silicon Valley start-ups, blocking access to significant amounts of Chinese capital.[106]

China's policy of fostering national champions and the U.S.'s attempts to beef up IP protection has far-reaching and sometimes perverse consequences. Huawei's close ties to the Chinese government and military, perceived by the U.S. as a security threat, has prevented it from bidding on U.S. government contracts. In 2018, AT&T dropped plans to sell Huawei phones in the U.S. and Australia banned Huawei and ZTE, another Chinese electronics company, from its next-generation mobile network.[107] In April 2018,

the U.S. threatened to cut off ZTE's access to U.S. components for its products, for fear hostile powers could enter American businesses through a back door and potentially steal data and spy on its businesses. Likewise, many companies are hesitant to create joint ventures or locate key R&D centers within China for fear of intellectual property theft. The danger of this sort of tit-for-tat sanctioning is the inadvertent dismantling and disruption of global supply chains, which could stunt technological innovation.

Likewise, despite strong evidence that technology clusters have benefited from immigration policies that have welcomed talent from all over the world, the Trump administration's hardline stance on immigration threatens to choke off a key supply of STEM workers. The H-1B visa program, which is the primary means by which U.S. companies hire high-skilled foreign workers, an already time-consuming and costly process, is becoming more onerous; U.S. government requests for information, which slow down the process, are increasing, as is the denial rate.[108] In early 2018, the Trump administration introduced plans to shorten the length of validity for some visas issued to Chinese nationals, specifically targeting those working in innovative areas highlighted in China's Made in China 2025 plan. The action is justified by the Trump administration as an attempt "to counter theft of U.S. intellectual property by Beijing."[109] But since Silicon Valley's workforce of graduates in STEM fields is only 40% homegrown, relying on a steady stream of foreigners for the balance, this move threatens to hurt U.S. innovation.

The NVCA has offered specific policy recommendations to help increase the inflow of foreign talent, including creating a start-up visa program that offers a separate category for immigrant entrepreneurs who create new businesses, are backed by venture capitalists or other investors, and create American jobs; reforming the H-1B visa system to increase the number that are granted to U.S. technology and healthcare companies; and creating a STEM visa to attract advanced degree holders.

A related problem is that technology companies worldwide are innovating faster than regulators can keep up with them. Technology is not constrained by borders, but its future development will be helped or hindered by legal and regulatory standards regarding momentous issues such as data privacy and intellectual property protection that are still taking shape and vary widely around the globe.

Comprehensive data protection laws are essential for protecting the right to privacy; many related freedoms depend on the ability to make choices about how and with whom personal user data is shared. The European Union has taken the lead in privacy law, with the General Data Protection Regulation, which allows individuals to control how their data is used, and protects data from loss, abuse or misuse.[110] China is charting its own course. In June 2017, China's new Cybersecurity Law (CSL) went into effect. In many ways it is as far-reaching as the European Union law in terms of regulating companies' use of personal data. Provisions include new requirements for cloud service platforms within mainland China, mandating that data storage for services targeting Chinese users remains in China.[113] Under the new rules, individuals and businesses can only use VPNs approved by the government and any self-constructed or leased lines will be prohibited for trans-border operations without approval. All business network services must be registered with the Chinese government for inspection. The government itself faces no such restrictions, however, and the effect of the CSL on innovation is an open question. The Conference Board cautions that if the CSL is enforced as written, it will have a damaging effect on companies' ability to collect and use customer data, speculating that "the next generation of BATs could die *in utero* in this kind of constrained data environment, particularly those focused on e-commerce, big data, and AI."[112]

Governments worldwide must walk a fine line with pubic trust as they roll out innovative "time savers" like AI facial recognition, a market forecast to be worth $6.5 billion by 2021, up from $2.3 billion in 2016.[113] China leads the world in the use of facial recognition technology in everyday life, with uses ranging from enabling authorities to spot criminal suspects to processing car rental transactions.[114] In the U.S., the use of facial recognition has been the subject of mounting public debate. Amazon has been selling facial recognition software it calls Rekognition to law enforcement agencies, sparking a letter

of protest from civil rights groups including the powerful American Civil Liberties Union. In the letter, the groups note: "People should be free to walk down the street without being watched by the government. Facial recognition in American communities threatens this freedom."[115]

China's NDRC in 2015 released a plan to create a virtual digital panopticon, monitoring its citizens with a public national video surveillance application that is now well underway. Its program to create a social credit system (SCS), using big-data collection and analysis to monitor, shape, and rate the behavior of its citizens is also underway. Though at first the government incentivized leading Chinese technology companies to create an SCS, planned rollouts by both Tencent and Alibaba were later blocked by the NDRC, which is expected to roll out its own. Worldwide, there is a thin line between protecting citizens using surveillance and violating civil liberties.[116]

The recent online peer-to-peer (P2P) lending crisis in China, in which hundreds of online lenders went bust after a wave of defaults rather than adhere to stricter regulations, also serves as a cautionary tale for technology companies that seek to disrupt highly regulated sectors such as finance and life sciences. As technologies become more complex, it is essential to craft and adopt regulatory and governance standards that protect consumers both domestically and overseas.

CONCLUSION

The acceleration of technological change and the heightened importance of technological innovation in advancing economic growth and national power increase the stakes for both China and the U.S. of getting their technology clusters right. Not only must they grow the technology clusters with speed and scale, but they must also ensure high-quality growth of these clusters, addressing the most pressing next-level challenges and ensuring better outcomes for all, rather than just a favored few. In a way, technological rivalry among the clusters in China and the U.S. can been seen as a new Cold War. But unlike the last Cold War, the two economies, and their technology sectors, are intertwined, through supply chains and human capital. Technologies like 5G are collaborative in nature, requiring involvement by companies from many countries, even beyond China and the U.S. The worrying development now is that both China and the U.S. show signs of closing in on themselves and turning their back on collaborative gains, and forgetting the past openness that has enabled each to become successful.

The jury is still out as to which technology cluster is better positioned to succeed in the 21st century. How China and the U.S. each deal with rising challenges, such as social and economic inequality within the microcosms of their fast-evolving technology clusters, can help develop techniques that can be rolled out on a national scale. Doing so will ensure that technological innovation goes beyond benefitting business and government elites to benefitting broader populations.

ENDNOTES

1 "Silicon Valley gets queasy about Chinese money," *The Economist*, August 9, 2018, https://www.economist.com/business/2018/08/11/silicon-valley-gets-queasy-about-chinese-money

2 "The 100 largest companies in the world by market value in 2018 (in billion U.S. dollars)," Statistica, accessed September 12, 2018, https://www.statista.com/statistics/263264/top-companies-in-the-world-by-market-value/; and "MIIT Ranks Top 100 Chinese Internet Companies," Pandaily, https://pandaily.com/miit-ranks-top-100-chinese-internet-companies/, accessed September 12, 2018.

3 "These are the world's largest tech giants," Jeff Desjardins, World Economic Forum, July 16, 2018 https://www.weforum.org/agenda/2018/07/visualizing-the-world-s-20-largest-tech-giants

4 "New Opportunities for the Guangdong-Hong Kong-Macau Greater Bay Area," PWC HK, 2017, https://www.pwchk.com/en/research-and-insights/editors-pick/new-opportunities-for-the-guangdong-hong-kong-macau-greater-bay-area.pdf

5 "From imitation to innovation: How China became a tech superpower," Christina Larson, *Wired*, February 13, 2018, https://www.wired.co.uk/article/how-china-became-tech-superpower-took-over-the-west; and "The Greater Bay Area Initiative: A survey on key drivers for success," KPMG, May 21, 2018, http://china-trade-research.hktdc.com/business-news/article/The-Belt-and-Road-Initiative/The-Greater-Bay-Area-Initiative-A-survey-on-key-drivers-for-success/obor/en/1/1X000000/1X0AE1NA.htm

6 "The Decline of the Port A look at the transformation of the Port of San Francisco," Urbanist Article, November 1, 1999, https://www.spur.org/publications/urbanist-article/1999-11-01/decline-port

7 "Understanding Silicon Valley," edited by Martin Kenney, Massachusetts Institute of Technology Working Paper Series, December 2000, https://ipc.mit.edu/sites/default/files/documents/00-014.pdf

8 "The Lawrence Berkeley National Laboratory 75th Anniversary Exhibit," Berkeley Lab website, accessed September 7, 2018 http://www2.lbl.gov/Publications/75th/files/exhibit.html; and "Understanding Silicon Valley," edited by Martin Kenney, Massachusetts Institute of Technology Working Paper Series, December, 2000, https://ipc.mit.edu/sites/default/files/documents/00-014.pdf

9 "Ernest O. Lawrence, Physicist University of California, Berkeley," Atomic Heritage Foundation website, accessed September 7, 2018, https://www.atomicheritage.org/profile/ernest-o-lawrence

10 "Beware the Big Five," Tamsin Shaw, *New York Review of Books*, April 5, 2018 issue, https://www.nybooks.com/articles/2018/04/05/silicon-valley-beware-big-five/, and https://www.sri.com/work/clients

11 "*A History of Silicon Valley*," Arun Rao and Piero Scaruffi, accessed September 7, 2018, http://www.scaruffi.com/svhistory/silicon.html

12 "Ames Research Center: R&D Lab for NASA," Nola Taylor Redd, Space.com website, January 12, 2018, accessed September 7, 2018, http://www.space.com/39381-ames-research-center.html

13 "Reimbursable Space Act Agreement (RSAA) Between NASA Ames Research Center and Lockheed Martin Space Systems, https://www.nasa.gov/sites/default/files/lockheed-martin-space-systems-saa2-400740.pdf

14 "Dot-com bubble," Wikipedia, accessed August 7, 2018, https://en.wikipedia.org/wiki/Dot-com_bubble

15 "Sci-tech innovation contributes 60% to Beijing's economic growth, "China.org.cn, June 20, 2017, http://www.china.org.cn/china/2017-06/20/content_41061361.htm; and "Beijing dominates China's artificial intelligence landscape," *Asia Times*, July 3, 2018, http://www.atimes.com/article/beijing-dominates-chinas-artificial-intelligence-landscape/

16 "Jing-Jin-Ji: China Planning Megalopolis the Size of New England," NBC News website, Eric Baculinao, March 26, 2017, accessed September 11, 2018, https://www.nbcnews.com/news/world/jing-jin-ji-china-planning-megalopolis-size-new-england-n734736

17 "Authorized to issue: The Central Committee of the Communist Party of China and the State Council decided to establish the Xiong'an New District of Hebei," Xinhaunet, April 1, 2018, http://www.xinhuanet.com/politics/2017-04/01/c_1120741571.htm

18 "A brave new world: Xi's Xiong'an," Cheng Li and Gary Xie, Brookings, April 20, 2018, https://www.brookings.edu/opinions/a-brave-new-world-xis-xiongan/

19 "A brave new world: Xi's Xiong'an," Cheng Li and Gary Xie, Brookings, April 20, 2018, https://www.brookings.edu/opinions/a-brave-new-world-xis-xiongan/; and "Benefits of building on our ties with China are clear," Charles Bowman, *The Telegraph*, March 21, 2018, https://www.telegraph.co.uk/business/2018/03/21/benefits-building-ties-china-clear/

20 "North China integration push eases income gaps," *Reuters*, March 13, 2018, https://www.reuters.com/article/us-china-parliament-jingjinji/north-china-integration-push-eases-income-gaps-official-idUSKCN1GQ0B9

21 "How 'China's MIT' Tsinghua University drives the country's tech ambitions," Celia Chen and Sarah Dai, *South China Morning Post*, May 6, 2018, https://www.scmp.com/tech/china-tech/article/2144741/how-chinas-mit-drives-countrys-tech-ambitions

22 "Chinese Workers Abandon Silicon Valley for Riches Back Home," Bloomberg Businessweek, January 11, 2018, https://www.bloomberg.com/news/articles/2018-01-10/chinese-workers-abandon-silicon-valley-for-riches-back-home

23 "China's Emerging Silicon Valley: how and Why Has Shenzhen Become a Global Innovation Centre," Xiangming Chen and Taylore Lynch Ogan. European Financial Review, December 22, 2016, http://www.europeanfinancialreview.com/?p=12327, and HKTDC website, accessed September 17, 2018, http://hkmb.hktdc.com/en/1X09VT4H/hktdc-research/Shenzhen-Guangdong-City-Information

24 "California Dreaming What makes Silicon Valley's iconic IT companies tick?," Jeanne Harris and Allan E. Alter, Accenture Outlook, accessed August 15, 2018, https://www.accenture.com/us-en/insight-outlook-california-dreaming-corporate-culture-silicon-valley; and "Facts on U.S. Immigrants, 2015 Statistical portrait of the foreign-born population in the United States," Pew Research Center, May 3, 2017, http://www.pewhispanic.org/2017/05/03/facts-on-u-s-immigrants/

25 National Venture Capital Association webpage, accessed June 29, 2018, https://nvca.org/public-policy/immigration/; and "Immigrants and Billion Dollar Startups," Stuart Anderson, National Foundation for American Policy, NFAP Policy Brief, March 2016, http://nfap.com/wp-content/uploads/2016/03/Immigrants-and-Billion-Dollar-Startups.NFAP-Policy-Brief.March-2016.pdf

26 "33 incredible perks Google, Netflix, and other US companies are offering their employees right now," Rachel Gillett, *Business Insider*, April 13, 2018, http://www.businessinsider.com/incredible-perks-companies-like-airbnb-facebook-and-google-offer-their-employees-2016-2/#generous-paid-parental-leave-at-netflix-1

27 "Chinese internet leaders are also HR pioneers," *Nikkei Asian Review*, November 3, 2017, https://asia.nikkei.com/Business/Chinese-internet-leaders-are-also-HR-pioneers2

28 'Beijing's Silicon Valley' offers express green cards for foreign spouses of top Chinese talent," Mandy Zuo, South China Morning Post, March 5, 2018, http://www.scmp.com/news/china/policies-politics/article/2135785/beijings-silicon-valley-offers-express-green-cards; and "In battle for global tech talent, Beijing offers foreign researchers the perk of bringing their own helpers," Amanda Lee, South China Morning Post, March 2, 2018, https://www.scmp.com/tech/article/2135371/battle-global-tech-talent-beijing-offers-foreign-researchers-perk-bringing

29 "Do tax incentives for research increase firm innovation? An RD Design for R&D," MIT, April 1, 2017, http://economics.mit.edu/files/12817 ;

30 IQT In-Q-Tel website, accessed September 11, 2018, https://www.iqt.org/sectors/national-security/

31 "Artificial Intelligence Is Now a Pentagon Priority. Will Silicon Valley Help?," Cade Metz, *New York Times*, August 26, 2018, https://www.nytimes.com/2018/08/26/technology/pentagon-artificial-intelligence.html

32 BYD Company, Limited 2017 Annual Report , accessed via HKEX website, http://www.hkexnews.hk/listedco/listconews/SEHK/2018/0327/LTN201803271463.pdf

33 "Sci-tech innovation contributes 60% to Beijing's economic growth," June 20, 2017, China.org.cn, http://www.china.org.cn/china/2017-06/20/content_41061361.htm ; and "How 'China's MIT' Tsinghua University drives the country's tech ambitions," Celia Chen and Sarah Dai, *South China Morning Post*, May 6, 2018, https://www.scmp.com/tech/china-tech/article/2144741/how-chinas-mit-drives-countrys-tech-ambitions

34 "Beijing to build technology park for developing artificial intelligence," Xinhuanet, January 3, 2018, accessed September 13, 2018, http://www.xinhuanet.com/english/2018-01/03/c_136869144.htm

35 "China's AI Agenda Advances," Elsa Kania, *The Diplomat*, February 14, 2018, https://thediplomat.com/2018/02/chinas-ai-agenda-advances/

36 "China's AI Agenda Advances," Elsa Kania, *The Diplomat*, February 14, 2018, https://thediplomat.com/2018/02/chinas-ai-agenda-advances/

37 "How 'China's MIT' Tsinghua University drives the country's tech ambitions," Celia Chen and Sarah Dai, South China Morning Post, May 6, 2018, https://www.scmp.com/tech/china-tech/article/2144741/how-chinas-mit-drives-countrys-tech-ambitions

38 "Capital gains taxation," Gerald Auden, accessed September 13, 2018, https://www.urban.org/sites/default/files/publication/71031/1000519-Capital-Gains-Taxation.PDF

39 "Silicon Valley Powered American Tech Dominance—Now It Has a Challenger," Phred Dvorak and Yasufumi Saito, *Wall Street Journal*, April 12, 2018, https://www.wsj.com/articles/silicon-valley-long-dominated-startup-fundingnow-it-has-a-challenger-1523544804

40 "Why startups are leaving Silicon Valley," The Economist, Aug 30, 2018, https://www.economist.com/leaders/2018/08/30/why-startups-are-leaving-silicon-valley

41 "Silicon Valley Powered American Tech Dominance—Now It Has a Challenger," Phred Dvorak and Yasufumi Saito, *Wall Street Journal*, April 12, 2018, https://www.wsj.com/articles/silicon-valley-long-dominated-startup-fundingnow-it-has-a-challenger-1523544804

42 "China's $798B Government Funds Redraw Investment Landscape, Here Are The Largest Funds You Must Know," Pan Yue, China Money Network, October 1, 2017, accessed September 11, 2018, https://www.chinamoneynetwork.com/2017/10/31/chinas-798b-government-funds-redraw-investment-landscape-largest-funds-must-know

43 "Silicon Valley Powered American Tech Dominance—Now It Has a Challenger," Phred Dvorak and Yasufumi Saito, *Wall Street Journal*, April 12, 2018, https://www.wsj.com/articles/silicon-valley-long-dominated-startup-fundingnow-it-has-a-challenger-1523544804

44 "2017 In Review: china's Ten Most Active VC Firms Join 460 Deals Worth $22 billion." China Money Network. (December 15, 2017). https://www.chinamoneynetwork.com/2017/12/15/2017-review-chinas-active-vc-pe-firms; and "Startup companies valued at one billion U.S. dollars or more by venture-capital firms worldwide, as of August 2018, by valuation (in billion U.S. dollars)," Statistica, https://www.chinamoneynetwork.com/2017/1,/31/chinas-798b-government-funds-redraw-investment-landscape-largest-funds-must-know

45 "About ChiNext," Shenzhen Stock Exchange website, accessed September 11, 2018, http://www.szse.cn/main/en/ChiNext/aboutchinext/

46 "Making sense of China's stock market mess," Arthur R. Kroeber, Brookings, July 13, 2015, accessed September 11, 2018, https://www.brookings.edu/opinions/making-sense-of-chinas-stock-market-mess/

47 "Class actions need to be allowed before dual classes of shares," Enoch Yiu, *South China Morning Post*, September 1, 2014, https://www.scmp.com/business/banking-finance/article/1582780/class-actions-need-be-allowed-dual-classes-shares

48 "Jack Ma Lays Out Hopes, Vision for Alibaba DAMO Academy," Alzila website, accessed September 13, 2018, https://www.alizila.com/jack-ma-lays-hopes-vision-alibaba-damo-academy/

49 Company websites: Alphabet, accessed September 13, 2018 https://abc.xyz/investor/pdf/20171231_alphabet_10K.pdf; Baidu, accessed September 13, 2018 http://media.corporate-ir.net/media_files/IROL/18/188488/2018/Baidu%202017%20Form%2020-F.pdf; Facebook, accessed September 13, 2018, https://s21.q4cdn.com/399680738/files/doc_financials/annual_reports/FB_AR_2017_FINAL.pdf, Tencent, accessed September 13, 2018, https://www.tencent.com/en-us/articles/17000391523362601.pdf; Alibaba, accessed September 13, 2018, https://www.alibabagroup.com/en/ir/pdf/agm160524_ar.pdf

50 "Let knowledge spread around the world," Martin Wolf, *Financial Times*, April 24, 2018, https://www.ft.com/content/1bdcf69c-470c-11e8-8ee8-cae73aab7ccb

51 "Sci-tech innovation contributes 60% to Beijing's economic growth," China.org.cn. June 20, 2017, http://www.china.org.cn/china/2017-06/20/content_41061361.htm ; "How 'China's MIT' Tsinghua University drives the country's tech ambitions," Celia Chen and Sarah Dai. South China Morning Post, May 6, 2018. https://www.scmp.com/tech/china-tech/article/2144741/how-chinas-mit-drives-countrys-tech-ambitions

52 "Global Innovation Index 2018," Cornell, INSEAD, WIPO, https://www.globalinnovationindex.org/Home

53 "China's first 'deep learning lab' intensifies challenge to US in artificial intelligence race," Meng Jing, *South China Morning Post,* February 21, 2017, accessed September 13, 2018, https://www.scmp.com/tech/china-tech/article/2072692/chinas-first-deep-learning-lab-intensifies-challenge-us-artificial

54 "Raising the Bar," James Lord, Cheung Kong Graduate School of Business Knowledge, Volume No. 29, Spring 2018. http://knowledge.ckgsb.edu.cn/2018/05/07/innovation/pearl-river-delta-innovation/

55 "China's Emerging Silicon Valley—How and why has Shenzhen become a global innovation center," The European Financial Review, December 22,2016, http://www.europeanfinancialreview.com/?p=12327 ; and "Raising the Bar," James Lord, Cheung Kong Graduate School of Business Knowledge, Volume No. 29, Spring 2018. http://knowledge.ckgsb.edu.cn/2018/05/07/innovation/pearl-river-delta-innovation/

56 "Annual Report 2017." Huawei company website. https://www.huawei.com/en/press-events/annual-report/2017

57 "The Factors Behind China's Growing Strength in Innovation," Jie Gan and Vijay Govindarajan, Harvard Business Review, July 2, 2018, https://hbr.org/2018/07/the-factors-behind-chinas-growing-strength-in-innovation

58 DJI official website, accessed September 13, 2018, https://www.dji.com/company

59 "From imitation to innovation: How China became a tech superpower," Christina Larson, *Wired*, February 13, 2018, https://www.wired.co.uk/article/how-china-became-tech-superpower-took-over-the-west

60 "China's Innovation Ecosystem." World Economic Forum. (August 2016). http://www3.weforum.org/docs/WEF_GAC_On_China_Innovation_WhitePaper_2016.pdf

61 "Disparity in Median Income between Highest and Lowest Educational Attainment Levels," Silicon Valley Indicators. org website, accessed September 13, 2018, https://siliconvalleyindicators.org/data/economy/income/personal-income/disparity-in-median-income-between-highest-and-lowest-educational-attainment-levels-table/

62 The Future of Work in the Age of the Machine," The Hamilton Project event, February 19, 2015. http://www.hamiltonproject.org/events/the_future_of_work_in_the_age_of_the_machine

63 Silicon Valley Competitiveness and Innovation Project, 2017, https://www.siliconvalleycf.org/sites/default/files/publications/Silicon Valleylg-report.pdf

64 "World Bank President: Automation Threatens 77% of Chinese Jobs," Gartner Talent Daily, October 5, 2016, https://www.cebglobal.com/talentdaily/automation-threatens-77-percent-chinese-jobs/

65 "Ex-Google Executive Opens a School for AI, With China's Help," Tom Simonite, *Wired,* April 5, 2018, https://www.wired.com/story/ex-google-executive-opens-a-school-for-ai-with-chinas-help/

66 "The Real Threat of Artificial Intelligence," Kai-Fu Lee, *New York Times*, June 24, 2017, https://mobile.nytimes.com/2017/06/24/opinion/sunday/artificial-intelligence-economic-inequality.html

67 "China's artificial intelligence plan," China Law Blog, March 19, 2018, https://www.chinalawblog.com/2018/03/chinas-artificial-intelligence-plan-stage-1.html

68 "China Internet Report 2018," Abacus, https://www.abacusnews.com/china-internet-report/

69 Congressman Ro Khanna website, accessed September 13, 2018, https://khanna.house.gov/media/in-the-news/progressive-democrats-counter-argument-trump-tax-plan-14-trillion-tax-credit; and, "The Political Education of Silicon Valley," Steven Johnson, *Wired,* July 24, 2018, https://www.wired.com/story/political-education-silicon-valley/

70 "Y Combinator learns basic income is not so basic after all," Nitasha Tiku, *Wired*, August 27, 2018, https://www.wired.com/story/y-combinator-learns-basic-income-is-not-so-basic-after-all/

71 "Shenzhen new home prices little changes for 18-straight month in March, as 'iron-fisted' measures calm market," *South China Morning Post*, April 3, 2018, https://www.scmp.com/property/hong-kong-china/article/2140065/shenzhen-new-home-prices-little-changed-18-straight-month and; "Hong Kong slaps property tax to close loophole," Venus Wu and Twinnie Siu, *Reuters*, April 11, 2017, https://www.reuters.com/article/uk-hongkong-property/hong-kong-slaps-property-tax-to-close-loophole-idUKKBN17D1DF

72 SiliconValleyMLS.com Home Values, Market Activity Trends, Schools and our Communities, accessed September 13, 2018 https://siliconvalleymls.com/

73 "Silicon Valley is changing, and its lead over other tech hubs narrowing," *The Economist*, September 1, 2018 https://www.economist.com/briefing/2018/09/01/silicon-valley-is-changing-and-its-lead-over-other-tech-hubs-narrowing

74 "The Cost of a Hot Economy in California: A Severe Housing Crisis" Adam Nagourney and Conor Dougherty, *New York Times*, July 17, 2017, https://www.nytimes.com/2017/07/17/us/california-housing-crisis.html

75 "One Thing Silicon Valley Can't Seem to Fix," Allison Arieff, *The New York Times*, July 8, 2017, https://www.nytimes.com/2017/07/08/opinion/sunday/silicon-valley-architecture-campus.html?mcubz=3&mtrref=www.google. com&gwh=4850FC7107AF0EC1D1305CFC4E84F27E&gwt=pay&assetType=opinion

76 "Commentary: Warning signs Silicon Valley cannot ignore," Brian Brennan and Erica Wood, *Mercury News*, May 28, 2017, https://www.mercurynews.com/2017/05/28/commentary-warning-signs-silicon-valley-cannot-ignore/amp/

77 Bay Area Council website, accessed September 13, 2018, http://www.bayareacouncil.org/2018-bay-area-council-poll/

78 "Shenzhen's largest 'urban village' thrives despite demolition orders," Emily Feng, *Financial Times*, July 27, 2018, https://www.ft.com/content/c44936ba-5f2b-11e8-9334-2218e7146b04

79 "Report: More graduates prefer second-tier cities," China News, June 12, 2018, http://www.ecns.cn/news/society/2018-06-12/detail-ifyuyvzv3228578.shtml

80 "Who Gets to Live in Silicon Valley?," Ingrid Burrington, *The Atlantic*, June 25, 2018, https://www.theatlantic.com/technology/archive/2018/06/who-gets-to-live-in-silicon-valley/563543/

81 "Google is beginning to get serious about the construction business," The Real Deal website, accessed September 13, 2018, https://therealdeal.com/la/2018/02/28/google-has-its-goggles-set-on-new-apartments-for-employees/

82 "Silicon Valley Competitiveness and Innovation Project 2017 Report," Silicon Valley Leadership Group and Silicon Valley Community Foundation, 2017, https://svcip.com/files/SVCIP_2017.pdf ; and "Gov. Brown just signed 15 housing bills. Here's how they're supposed to help the affordability crisis," Liam Dillon, *Los Angeles Times*, September 29, 2017, http://www.latimes.com/politics/la-pol-ca-housing-legislation-signed-20170929-htmlstory.html

83 "Rent control, affordable housing, state division set for November ballot," Adam Brinklow, Curbed, July 2, 2018, https://sf.curbed.com/2018/7/2/17525268/rent-control-affordable-housing-three-californias-ballot-2018

84 "Chinese tech groups offer housing help retain talent," Louise Lucas, *Financial Times*, April 25, 2017, https://www.ft.com/content/6b67eb56-2884-11e7-bc4b-5528796fe35c

85 "Chinese tech groups offer housing help retain talent," Louise Lucas, *Financial Times*, April 25, 2017, https://www.ft.com/content/6b67eb56-2884-11e7-bc4b-5528796fe35c

86 "China Starts Experiment to Tame Its Wild Property Market," Paul Panckhurst, Bloomberg, January 25, 2018, https://www.bloomberg.com/news/articles/2018-01-24/xi-seeks-to-tame-china-s-wild-property-market-with-rental-push

87 "China's Shenzhen to cap new private homes at 40 percent of supply," Reuters, June 5, 2018, https://www.reuters.com/article/us-china-economy-property-shenzhen/chinas-shenzhen-to-cap-new-private-homes-at-40-percent-of-supply-idUSKCN1J11E3

88 "China Toughens Housing Policy as Shenzhen Imposes More Curbs," Bloomberg, July 31, 2018, https://www.bloomberg.com/news/articles/2018-08-01/shenzhen-slaps-3-year-delay-on-flipping-homes-in-latest-curbs; and "China's Politburo Signals Greater Focus on Growth Amid Trade Standoff," Bloomberg, July 31, 2018, https://www.bloomberg.com/news/articles/2018-07-31/china-politburo-signals-greater-focus-on-growth-amid-trade-spat

89 "A brave new world: Xi's Xiong'an." Cheng Li and Gary Xie, Brookings Institution, April 20, 2018, https://www.brookings.edu/opinions/a-brave-new-world-xis-xiongan/

90 "How Tianjin, once China's fastest-growing region, became its slowest," *The Economist*, August 2, 2018, https://www.economist.com/china/2018/08/02/how-tianjin-once-chinas-fastest-growing-region-became-its-slowest

91 Amazon.com website, HQ2 RFP PDF, accessed September 13, 2018, https://images-na.ssl-images-amazon.com/images/G/01/Anything/test/images/usa/RFP_3._V516043504_.pdf

92 Richard A. Walker, *Pictures of a Gone City: Tech and the Dark Side of Prosperity in the San Francisco Bay Area*, PM Press, 2018

93 "Silicon Valley's Toxic Past Haunts Sunnyvale Neighborhood," Beth Winegarner, KQED Science website, June 15, 2017, accessed September 13, 2018, https://www.kqed.org/futureofyou/388730/silicon-valleys-toxic-past-haunts-sunnyvale-neighborhood

94 "Build up climate change resilience in the Bay Area," Janet Pau, China Daily Hong Kong, July 31, 2018, https://www.chinadailyhk.com/articles/154/110/90/1533005753866.html

95 "A brave new world: Xi's Xiong'an." Cheng Li and Gary Xie, Brookings Institution, April 20, 2018, https://www.brookings.edu/opinions/a-brave-new-world-xis-xiongan/

96 "Xiongan's Cleanup Efforts Don't Hold Water," Zhou Chen, Li Rongde and Yao Xiaohui, *Caixin*, July 2, 2018, https://www.caixinglobal.com/2018-07-02/xiongan-new-areas-cleanup-efforts-dont-hold-water-101289787.html

97 "Xiongan's Cleanup Efforts Don't Hold Water," Zhou Chen, Li Rongde and Yao Xiaohui, *Caixin*, July 2, 2018, https://www.caixinglobal.com/2018-07-02/xiongan-new-areas-cleanup-efforts-dont-hold-water-101289787.html

98 "Shenzhen leads the way in switch to electric buses," Chong Koh Ping, *The Straits Times*, January 27, 2018, https://www.straitstimes.com/asia/east-asia/shenzhen-leads-the-way-in-switch-to-electric-buses

99 http://www3.weforum.org/docs/WEF_GAC_On_China_Innovation_WhitePaper_2016.pdf

100 RE100 website, accessed September 13, 2018, http://there100.org/companies; and "Renewable Energy Buyers Alliance Summit", Greezbiz website, accessed September 9, 2018, https://www.greenbiz.com/events/reba/oakland/2018,

101 "A Start-Up Slump Is a Drag on the Economy. Big Business May Be to Blame," Ben Casselman, *New York Times*, September 20, 2017, https://www.nytimes.com/2017/09/20/business/economy/startup-business.html

102 Walkthechat website, accessed September 17, 2018, https://walkthechat.com/douyin-became-chinas-top-short-video-app-500-days/

103 "Bytedance and Tencent legal battle escalates," *Financial Times*, June 1, 2018, https://www.ft.com/content/13f5ceb2-5f18-11e8-9334-2218e7146b04

104 "A Big Choice for Big Tech," Viktor Mayer-Schönberger and Thomas Ramge, *Foreign Affairs*, September/October 2018 Issue, https://www.foreignaffairs.com/articles/world/2018-08-13/big-choice-big-tech

105 "Why Companies and Countries Are Battling for Ascendancy in 5G," Don Clark and Cecilia Kang, *The New York Times,* https://www.nytimes.com/2018/03/06/technology/companies-countries-battling-5g.html; and "U.S. Calls Broadcom's Bid for Qualcomm a National Security Risk," Alan Rappeport and Cecilia Kang, *The New York Times,* March 6, 2018, https://www.nytimes.com/2018/03/06/business/qualcomm-broadcom-cfius.html?hp&action=click&pgtype=Homepage&clickSource=story-heading&module=first-column-region&region=top-news&WT.nav=top-news

106 "Silicon Valley gets queasy about Chinese money," *The Economist*, August 9, 2018, https://www.economist.com/business/2018/08/11/silicon-valley-gets-queasy-about-chinese-money; and "CIFIUS Update," White and Case website, July 14, 2018, accessed September 13, 2018, https://www.whitecase.com/publications/alert/cfius-update

107 Letter from the U.S. House of Representatives to Huawei senior management, June 12, 2012 (pdf), https://intelligence.house.gov/sites/intelligence.house.gov/files/documents/huaweicharlesding12june2012.pdf; and "Who's Afraid of Huawei? Security Worries Spread Beyond the U.S.," Dan Strumpf, Rob Taylor, and Paul Vieira, *Wall Street Journal,* March 20, 2018, https://www.wsj.com/articles/whos-afraid-of-huawei-security-worries-spread-beyond-the-u-s-1521561391?mod=article_inline

108 "The H-1B visa: A golden ticket loses its luster," Trisha Thadani, The San Francisco Chronicle website, accessed September 13, 2018, https://www.sfchronicle.com/business/article/The-H-1B-visa-in-the-age-of-Trump-A-golden-13015356.php

109 "AP sources: US to impose limits on some Chinese visas," Josh Lederman and Ted Bridis, AP News Website, May 29, 2018, accessed September 13, 2018, https://apnews.com/82a98fecee074bfb83731760bfbce515

110 "The EU General Data Protection Regulation: Questions and Answers," Human Rights Watch website, June 6, 2018, accessed September 13, 2018, https://www.hrw.org/news/2018/06/06/eu-general-data-protection-regulation

111 "Understanding China's Cybersecurity Law," New Zealand Ministry of Foreign Affairs and Trade, accessed September 13, 2018, https://www.mfat.govt.nz/assets/China/Understanding-Chinas-cybersecurity-law.pdf

112 "China's Cybersecurity Law Managing around the 'Great Firewall': appraising new Cyber Security Law requirements, risks and work-arounds," The Conference Board China Center, May 2018, quoted with permission from TCB.

113 "Beijing's new Zaha Hadid-designed airport to showcase latest facial recognition technology," Sarah Dai, *South China Morning Post,* July 18, 2018, https://www.scmp.com/tech/article/2155606/beijings-new-zaha-hadid-designed-airport-showcase-latest-facial-recognition

114 "Beijing's new Zaha Hadid-designed airport to showcase latest facial recognition technology," Sarah Dai, *South China Morning Post,* July 18, 2018, https://www.scmp.com/tech/article/2155606/beijings-new-zaha-hadid-designed-airport-showcase-latest-facial-recognition

115 PDF of letter from U.S. civil rights groups to Jeff Bezos of Amazon, May 22, 2018, https://www.aclunc.org/docs/20180522_AR_Coalition_Letter.pdf; and "Amazon Pushes Facial Recognition to Police. Critics See Surveillance Risk," Nick Wingfield, *The New York Times,* May 22, 2018, https://www.nytimes.com/2018/05/22/technology/amazon-facial-recognition.html

116 "Technology-enhanced authoritarian control with global consequences," Australian Strategic Policy Institute Website, accessed September 13, 2018, https://www.aspi.org.au/report/social-credit