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From the perspective of technological competition, countries around the world are focusing their eyes on the key technologies like artificial intelligence (AI), advanced manufacturing, semiconductor, quantum information science and 5G, which are shaping the future economic development. Nations with strengths in the above areas begin to take a protectionist approach to their own technologies. This, however, will also force China to enhance its own innovation capability, and thus technological innovation in China will see an unprecedented opportunity to thrive on its own feet.

Each of the innovation ecosystems in developed countries has its own merits. The US emphasizes more on building an ecosystem led by innovation clusters; Israel is promoting robust innovation development with a risk investment system driven by its government; Germany focuses on a stable and sustained foundation for innovation. China, after prioritizing innovation as a national core strategy, continues to open up its market, committed to driving stable growth of its technological innovation capabilities through ongoing and increasing investment in talents and technologies.

An innovation ecosystem can be evaluated by three indicators. The first is innovation institution, which reflects the number of innovation entities in a city, and the city’s capability of conducting technological R&D and business innovation. The second is innovation resource, which indicates whether the various factors owned by a city could support innovation institutions to innovate. The third is innovation environment, which shows whether a city could attract and retain the best innovation resources to create a good external environment for a cluster of innovation institutions.

In terms of innovation ecosystems, cities in China can be ranked and divided into three tiers based on their evaluated scores. Among the first tier, Tier 1 cities including Beijing, Shanghai, Shenzhen and Guangzhou remain at the top, with Hangzhou rising to the forth place in replace of Guangzhou. Nanjing, Chengdu and Wuhan are among the top few in the second tier. The third tier mainly includes cities that promote breakthroughs of innovation ecosystems via policy guidance, such as Dongguan, Foshan, Zuhai and Guiyang.
Manufacturing is the fundamental industry for the development of innovation in China, where the advancement of smart manufacturing ecosystem would not be possible without deep dive of user values. For example, enterprises could embed new technologies during R&D and design to produce more intelligent and more diverse products; provide equipment-related financial services at sales stage; monitor in real time and collect data of equipment and products for aftersales, and offer performance analysis and predictive maintenance, enhancing security while creating more service opportunities for enterprises. That's why the whole smart manufacturing ecosystem needs tech companies of intelligent products, financial services enterprises, data collection and analysis enterprises, security performance testing firms, etc. China has a complete set of supporting industries for manufacturing, and therefore could help manufacturing enterprises go even further on the journey of smart upgrade.

From a regional perspective, China's innovation ecosystems have some distinct features. As the core of the innovation ecosystem of the Beijing-Tianjin-Hebei region, Beijing dominates the region in terms of innovation institutions and resources, and also takes the lead in innovation environment. Innovation in the Yangtze River Delta region is generally more mature than that of other regions, with strong drives from Shanghai and Hangzhou, as well as Nanjing and Suzhou in the second tier innovation cities. The development of Guangdong-Hong Kong-Macau Greater Bay Area (GBA) will be led by Shenzhen; Dongguan, Foshan and Zhuhai could expect a promising future under the GBA planning despite the absence of innovation advantages. Core cities in Central and Western China are seeing a rapid development of innovation ecosystems driven by policies.

The best practice of innovation ecosystems in China is no doubt the AI industry. The strength of China in AI not only comes from massive search data, a rich variety of product lines and market advantages based on a wide range of industries, but also is driven by efforts of tech giants in building open-source technological communities, which have helped start-ups at AI application level break technological barriers to apply AI technologies directly in R&D of terminal products. Fuelled by both policies and capital, the number of AI enterprises is rising rapidly. Incomplete statistics shows that there are more than 1,000 AI enterprises across China, with the most located in Beijing-Tianjin-Hebei region, Pearl River Delta region and Yangtze River Delta region. A significant effect of industry agglomeration is driving more complete ecosystems.
China still faces challenges in driving the development of innovation, and in particular needs to catch up with developed countries in respect of core technologies. With increased R&D investment and the number of patents, China’s innovative enterprises and innovative products have already obtained some competitive edges. However, in areas of communications, manufacturing of electronic devices and precision instruments as well as auto making, including semiconductor materials and production, ultra-high-precision machine tools and electronic gasoline injection system, etc., China remains at its infancy of development, yet to master core technologies in certain sectors, and are highly dependent on foreign technologies. A main reason for this is the imbalance of R&D input and output, with lack of R&D input at basic level. The government should also consider in depth how to further enhance the execution of and improve supporting policies. Lastly, the introduction and accumulation of talents remains a long process.

The booming digital economy is driving China’s innovation to go global, and has become an important source of GDP growth in China. In 2018, China’s digital economy grew to a size of RMB31.3 trillion, an increase of 20.9%, accounting for 34.8% of total GDP. Driven by digitalization, China’s innovative technologies and products are going global. In the future, China could leverage more Internet-based innovation and upgrade to climb up the international industry chain, cultivate new economic drivers, and optimize structures.

Capital markets led by the STAR Market provide full support for the continuous optimization of China’s innovation ecosystem. Launched in 2019, the STAR Market primarily supports high-tech industries and strategic emerging industries, including next generation information technologies, high-end equipment, new materials, new energy, energy conservation and environmental protection, and biomedicine. Capital markets have supported the development of innovation in China, and the STAR Market as a branch of the secondary market is a symbol of growing capital support for China’s innovation ecosystem as capital markets respond to the call for innovation-driven development and capture new opportunities brought by technological innovation. Next, capital markets should further improve their dialectical relations with innovative enterprises. They should enhance their inclusion and flexibility to technological and innovative start-ups, working to strengthen the lead of capital in boosting technological innovation and the support to energize market players; on the other hand, they should also increase transparency of information in enterprises, improve screening mechanisms, and prevent “false innovation” and overheating of capital.
Chapter 1 Innovation as a new driver for economic growth

1.1 Innovation has become the focus of global competition
Influenced by the slowdown of the world economy as a whole, risks are accelerating to build up, and shift of economic strength has triggered the reordering of international governance and power. Rising unilateralism and protectionism are impacting the international order and multilateral trade system. Under a downward economic trend, countries around the world are stepping up efforts in promoting technological innovation to sustain their own strengths. At the same time, technological innovation as an indication of the overall strength of a nation is being used increasingly by protectionists to restrict other economies.

As science and technology becomes increasingly important in driving national economic development, governments all over the world are placing innovation as a core strategy at national levels, presenting a new pattern of competition for innovation globally. Major countries have all deployed in advance future-oriented technological innovation strategies and initiatives. Since the beginning of the 21st century, the US as a global leader in technological innovation has launched a series of national strategies focusing on innovation, and allocated massive facilities to drive basic researches. Germany has promulgated research enhancement policies on advanced production technologies, which enabled the research and development digital production technologies for the Fourth Industrial Revolution, also known as Industry 4.0, and has delivered multiple projects in cooperation among the industry, academia and the government. Japan, Korea and emerging economies including Russia, Brazil and India are all actively introducing national innovation development strategies or planning.
**Figure 1: Major world economies are promoting innovation as a national strategy**

<table>
<thead>
<tr>
<th>Country</th>
<th>Policy/Strategic Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>United States</strong></td>
<td>Memorandum on FY2019 Administration Research and Development Budget Priorities</td>
</tr>
<tr>
<td></td>
<td>Proposes to advance innovative basic research, infrastructure, and talent development</td>
</tr>
<tr>
<td><strong>United Kingdom</strong></td>
<td>Our Plan For Growth: Science And Innovation (2014)</td>
</tr>
<tr>
<td></td>
<td>Proposes 6 policies to promote development of top talent, investment in scientific equipment, etc.</td>
</tr>
<tr>
<td><strong>Germany</strong></td>
<td>Industrial Strategy (2017)</td>
</tr>
<tr>
<td></td>
<td>Proposes to raise total R&amp;D investment to 2.4% of GDP by 2027</td>
</tr>
<tr>
<td><strong>France</strong></td>
<td>High-Tech Strategy (2014)</td>
</tr>
<tr>
<td></td>
<td>Proposes to concentrate on areas that feature especially dynamic innovation</td>
</tr>
<tr>
<td><strong>China</strong></td>
<td>France Europe 2020 (2015)</td>
</tr>
<tr>
<td></td>
<td>Proposes priority areas by 2020, defines priority research directions and five thematic initiatives to address top 10 societal challenges in France, emphasizes on application-oriented research, and focuses on addressing societal challenges France faces</td>
</tr>
<tr>
<td><strong>South Korea</strong></td>
<td>13th Five-year Plan on National Technological Innovation (2016)</td>
</tr>
<tr>
<td></td>
<td>The National Plan for Medium and Long-term Technological Development sets out the goal to develop as an innovative country by 2027, and the Outline of the National Strategy of Innovation-Driven Development defines the phased goals by 2050</td>
</tr>
<tr>
<td><strong>Japan</strong></td>
<td>“Realizing economic co-prosperity”</td>
</tr>
<tr>
<td></td>
<td>Proposes “the Fourth Industrial Revolution that leads technological development” (one of the five key strategies) and three “issues of national affairs” (the Fourth Industrial Revolution, creating environment for technological innovation, supporting young scientists and basic research)</td>
</tr>
</tbody>
</table>

Source: Public information, Deloitte Research
Data from UNESCO shows that total R&D investment has reached USD1.7 trillion globally. Developed countries still maintain their distinctive lead in innovation, which, however, is shifting the presence eastwards. Innovation resources such as top technological talents and patents are still dominated by developed countries, but the share of the US and Europe in total R&D investment globally has dropped from 61% to 52%, and that of Asian economies has risen from 33% to 40%, with significant increase in the share of BRICS nations.

Figure 2: Top 10 countries by R&D investment in 2018 (USD billion)

Source: UNESCO, Deloitte Research

From the perspective of technological competition, countries around the world are focusing their eyes on key technologies like AI, advanced manufacturing, semiconductor, quantum information science and 5G, which are shaping the future economic development. Nations with strengths in the above areas begin to take a protectionist approach to their own technologies. As a late starter in technological innovation, China is still lagging far behind in core underlying technologies for emerging strategic technological innovation, such as upstream basic parts for semiconductors, which still need to be imported. From ZTE to Huawei, cases of China being suppressed by technologically advanced countries are not rare. With intensifying competition for technological innovation across the globe, China is facing enormous challenges in promoting technological innovation. This, however, will also force China to enhance its own innovation capability, and thus technological innovation in China will see an unprecedented opportunity to thrive on its own feet.

Figure 3: Global R&D investment in 2018 by industry

Source: IRI EU, Deloitte Research
1.2 China’s innovation ecosystem is thriving

Where is China standing within the global innovation landscape? Has China gone beyond the “quick follower” type of innovation, and grown gradually as a global leader in innovation? In the global innovation landscape, China has climbed from the 26th place in 2016 up to the 14th in 2019, and is the only middle-income economy among the top 30.¹ There has been significant progress made by China in its innovation indicators from various aspects, ranking top in terms of domestic patents, industrial design, original trademark, high-tech net exports and export of creative products, etc.² China is entering into a new stage of development for innovation.

**Figure 4: China’s standing in global innovation landscape**

Source: Global Innovation Index 2019, Deloitte Research

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¹ Based on rankings of Global Innovation Index reports from 2016 to 2019
² Global Innovation Index 2019

The Chinese government has attached great importance to the core position of innovation in national economic development. China officially established strategic emerging industries in 1992 after reform and opening up, and started to explore deeper into technology-driven governance in 2009, the second year after the global financial crisis. Then it realized that the competition of international economic and technological development was growing intensified, and it could only overcome negative impacts of the global financial crisis by stepping up institutional innovation and technological innovation. China has developed national mid-term and long-term plans for scientific and technological development that set building an innovative nation as a strategic goal; put in place plans to develop nine strategic emerging industries including next generation information technologies, high-end equipment, new materials, bio industry, new energy vehicles, new energy, energy conservation and environmental protection, digital creativity and related service industry. As of the first half of 2018, strategic emerging industries and service industry have grown 30% faster than the overall growth nationally, constantly leading economic development. The growth of China’s strategic emerging industries is driving GDP growth by over one percentage point annually in average, accounting for nearly 20% of total growth, far higher than the share of these industries in total GDP.
Rising Innovation in China | Chapter 1 Innovation as a new driver for economic growth

The Chinese government has been actively supporting the development of innovative start-ups by creating a favorable environment for them. In 2014, Premier Li Keqiang put forward the concept of "mass entrepreneurship and innovation" to support the development of innovative start-ups. The policy provides a sound growing environment for start-ups in China, and the Chinese government has created positive conditions for start-ups in terms of financial investment, tax preferences and talent attraction. In 2017, the State Tax Administration issued Guidelines on Tax Incentives for Mass Entrepreneurship and Innovation, which cuts corporate income tax of micro businesses by half and gradually expands the scope of taxation from less than RMB300,000 of annual taxable income to less than RMB3 million. In July 2019, the Ministry of Public Security introduced new immigration and exit-entry facilitation policy to attract more top foreign talents to start businesses and invest in China. However, there still remain significant gaps between China and developed countries in terms of regulatory environment. Policy makers should consider opening up more economic fields to bring in a competitive market, and providing more legal protection for China’s innovation system by strengthening protection of intellectual property rights, developing consistent and coordinated policies and improving the credit system for small and medium-sized enterprises.

China's investment in talents and technology for innovation and R&D continues to rise.
For a long time, China's significant and continued investment in scientific research has driven the country to overtake traditional technological powers in a number of research indicators within just a few years. Chinese companies have begun to emerge in the international community in terms of their R&D investment in innovation. The Economics of Industrial Research and Innovation (IRI), a research institution under the European Commission, publishes each year a list of top 2,500 companies across the world by the amount of their R&D investment, and the number of Chinese companies included in the list is stably increasing every year. Over the past decade, R&D investment of Chinese companies listed has been growing at a much faster rate than the world average growth.
China ranks top globally with the absolute number of researchers, scientific and technological publications and domestic patent applications. Its R&D spending accounts for 2.1% of total GDP, ranking the 15th globally.3 Scientific research strengths of Chinese universities and colleges have been greatly improved and six universities in the Chinese Mainland rank among the top 100 global universities in the QS World University Rankings 2020, while the number was only four in 2017. The focus of China's scientific research is shifting from pursuing the greatest number of research papers to enhancing the quality and international influence of such papers. In 2018, China ranked the 4th globally by the number of papers published on key international academic journals, and the 2nd by the number of citations.4 As to technological innovation, China ranks the 2nd by the number of PCT patent applicants after the US, and Huawei tops the world as company applicant in 2018.5 As PCT patent application is an indicator proving the strength of a country in technological innovation, this shows that China has developed into a major power in technological innovation. However, China still needs to enhance the improvement of productivity and the results brought by the commercialization of technologies driven by huge investment in scientific research, as China ranks 28th among 54 countries in terms of R&D transfer, far behind the US, Israel and other developed economies.6

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1 Data from UNESCO database
3 Based on 2018 WIPO statistics
4 Based on rankings of Global Entrepreneurship Monitor 2018/2019 Report

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Figure 6: R&D investment growth of Chinese companies vs. global companies in the top R&D list

Source: IRI EU, Deloitte Research
Talent is the top resource and the driving force of technological innovation, and policies on education and talents are one of the core indicators for evaluating the innovation system of a country. Over the past decades, China’s investment in education from the state and the private sector has provided a large number of engineering and technological talents for entrepreneurship and innovation, and is narrowing the gaps between China and developed countries. China stands at the 13th place in education rankings, ahead of the US and Israel, but falls far behind the average level of developed countries in terms of enrolment rate of higher education.7

The development of ICT and Internet is driving industry innovation in China.

Innovation in China has developed alongside the growth of communications and consumer internet sectors. ICT and internet companies, led by Huawei, ZTE, Baidu, Alibaba, Tencent and JD.com, have emerged rapidly through leading-edge technologies and business models. Internet start-ups in China peaked in 2015, with 16,239 new companies established. From 2016, the number of internet start-ups in China started to “cool down”, and the number of new internet companies established in 2017 was 2,900, a decline of 64.9% from 2016. From the size of start-ups, however, China and the US house half of the world’s unicorns. As of August 2019, China has 96 unicorn start-ups, ranking the 2nd in the world. In particular, Toutiao becomes the highest valued unicorn across the globe with market value of USD75 billion.8

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7 Based on statistics from Global Innovation Index 2019 report.
8 CBINSIGHTS database, as of August 2019.
China had 32 new unicorn start-ups in 2018, a first drop in its global share of new unicorns due to impact of financial deleverage measures in the country and other factors. As seen from industry distribution, China’s unicorns mainly come from consumer and service sectors, and they often pursue innovation of business models through the combination of traditional industries with technologies such as internet. There is a significant gap between China and the US with the number of unicorns engaged in technological innovation. Since 2018, however, high-tech unicorns led by SenseTime are coming into the spotlight from AI, robotics, new energy vehicles and big data fields.

Venture capital and incubators are the catalyst and nutrient for the whole entrepreneurship ecosystem. In 2018, China’s total venture capital amounted to USD93.8 billion, USD2.2 billion higher than that of the US in the 2nd place, indicating that the US-dominated global entrepreneurship and innovation ecosystem is now positively driven by China. From the average amount of investment, China tops the world with an average of USD30 million per deal. In 2018, China has more than 4,849 incubators and 6,959 maker spaces, which also rank top across the globe. More than 60% of the incubators are run by private companies via market-based means.

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[9] Crunchbase database
1.3 Characteristics of innovation ecosystems in developed countries

1.3.1 US: Innovation ecosystem driven by innovation clusters

The US has been leading the world in innovation. Especially after WWII, massive investment in scientific research for military purposes by the government has further catalyzed and improved its innovation ecological chain and entrepreneurship capital system. The US ranks the 3rd in global innovation rankings, up three places from that in 2018.\(^1\) In recent years, as the EU and China awake and rise in innovation, the US’s innovation leadership is facing various pressures and challenges.

The US government has always emphasized highly on the design of innovation strategy, and published a series of policies from the *American Competition Law* in 2007, to the *American Recovery and Reinvestment* and *A Strategy for American Innovation: Driving towards Sustainable Growth and Quality Jobs* in 2009, to the *A Strategy for American Innovation: Securing Our Economic Growth and Prosperity* in 2011. The US government has promoted and maintained its leadership in global innovation via scientific research investment, legislation building and provision of financing channels. Currently, the US government invests over USD150 billion annually to support the research of federal laboratories and commercialization of scientific research results by universities.\(^2\) Moreover, the US has developed a sound legal system and a solid set of regulatory mechanisms for technological innovation, including intellectual property rights policies and anti-monopoly law enforcement, providing a favorable legal environment for investors and entrepreneurs. The US government also provides multiple financing channels for small and medium-sized enterprises, and motivates them via loans, tax incentives and fiscal subsidies. But during the Trump administration, the US government has reduced to a certain extent the support to technological innovation. Spending in non-defense scientific research by the US government has dropped from 1.2% of total GDP in 1976 to 0.7% in 2018.\(^3\) In 2016, tax subsidy rate for R&D spending in the US ranked 32nd among 35 countries, behind China and Brazil.\(^4\)

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\(^1\) Based on Global Innovation Index 2018-2019 report

\(^2\) Data from the United States Studies Centre at the University of Sidney: https://www.ussc.edu.au/analysis/innovation-policy-in-the-united-states-and-australia

\(^3\) OECD database

\(^4\) Public Policy Initiative, the Wharton School of the University of Pennsylvania: http://publicpolicy.wharton.upenn.edu/live/news/1840-primer-innovation-policy-in-the-united-states
The US has been surpassed by late starter such as China in the number of scientific researches, fiscal spending and other indicators. However, as evaluated from university rankings, patent applications and paper citations, the US tops the world by its quality of innovation. In 2018, total R&D spending of the US totalled USD543.2 billion, the highest across the world, accounting for 2.8% of total GDP. 

Twenty-nine US universities are included in the world's top 100 by the QS World University Rankings, with five of the top 10 based in the US, and Massachusetts Institute of Technology has been ranking top of the list for many years. In 2016, there were more than 400,000 research papers published in the US, and, despite that China has become the largest country around the world in the production of scientific papers and that its number of researches and papers has exceeded the US, the US remained ahead of China by the most cited 1% articles.

Innovation clusters are the main body of innovation in the US, where there are six major innovation clusters whose conditions for sustainable development can be summarized into six points: core industry competitiveness, human resources with technical expertise, strong leadership, stable market demand, sound infrastructure, favorable regulatory environment for innovation, and acceptance of industry development by local people, etc. A typical model of innovation ecosystem driven by innovation clusters is the Silicon Valley, which is led by universities, government and entrepreneurs. The Silicon Valley is the pioneer of the semiconductor revolution, and the US Department of Defense was its biggest client at the beginning of its development. In the field of scientific research, the Silicon Valley has benefited from Stanford University and University of California, Berkeley. At the same time, California with a free and open economic system and labor market has attracted a great number of high-tech immigrants. As local innovation ecosystem evolves and develops, the Silicon Valley has become a paradise for angel investors and venture capitals, and large multinational companies have also become its backbone.

Most of the world's best incubators and accelerators come from the US. Y Combinator, a well-known incubator based in the US, has invested in more than 1,500 start-ups, with total investment exceeding USD80 billion, and helped many companies such as Dropbox and Airbnb achieve success. As of August 2019, there are 191 unicorn start-ups in the US, ranking top across the world and accounting for almost half of the total in the world. These start-ups mainly engage in internet software and services, Fintech, AI and e-commerce. The volume of venture capital in the US in 2018 exceeded USD130 billion, with deals involving corporate venture capital functions more than doubled and total volume of corporate VCs surpassing traditional VCs for the first time.

![Figure 11: Unicorns in the US by industry (2019)](image)

Source: CBINSIGHTS database, Deloitte Research

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14 OECD database
15 QS World University Rankings 2020
16 Data from National Science Foundation, United States
17 Clusters and Innovation Districts: Lessons from the United States Experience, the Brookings Institution
18 CBINSIGHTS database
19 Pitchbook database
1.3.2 Israel: Risk investment system led by the government
Israel ranks among the top 10 globally for the first time in the Global Innovation Index in 2019. The country has been in an invincible position for years in technological innovation, powered by its high quality talents, entrepreneurship, spirit of bold innovation, as well as the government’s long-term support for technology research. Start-ups from Israel are leading technological breakthroughs in different areas around the world, especially in industries such as communications, internet, healthcare, agriculture, biotechnology, security, sea water desalination, etc. R&D spending accounts for 4.6% of Israel’s GDP, far higher than that of the US, China and Germany. Israel has more than 8,000 researchers in every million of its population, with the number of per capita almost doubling that of the US, and it also ranks top across the world by the number of innovative enterprises per capita and the number of high-tech companies per capita. It follows Japan, Sweden, Switzerland and South Korea at the 5th globally by the number of patents per capita. Though a small country with a land area of 21,000 square kilometers, a population of eight million, scarcity in natural resources and at war ever since founded, it now is recognized as a global leading innovation center known as the "land of entrepreneurs" and "Silicon Valley of the world".

**Figure 12: R&D spending (2017)**

![R&D spending (2017)](chart)

Source: OECD database, the Global Competitiveness Report 2018, Deloitte Research
Israel highly values education, with education spending accounting for 5.9% of its GDP, ranking 22nd across the world; while education spending accounts for 5.0% of GDP in the US, ranking 28 places behind Israel. There are nine universities in Israel, six of which make their names in the QS World University Rankings 2020.

**Figure 14: Education spending (2017)**

<table>
<thead>
<tr>
<th>Country</th>
<th>Education Spending (%)</th>
</tr>
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<tbody>
<tr>
<td>Israel</td>
<td>5.90</td>
</tr>
<tr>
<td>US</td>
<td>5.00</td>
</tr>
<tr>
<td>Germany</td>
<td>4.80</td>
</tr>
<tr>
<td>China</td>
<td>4.14</td>
</tr>
</tbody>
</table>

Source: UNESCO UIS database, Global Innovation Index 2019, Ministry of Education, Deloitte Research
Israel’s strong competitiveness in innovation is the result of the combination of government-led risk investment policies and a culture of entrepreneurship. By undertaking high-risk investments, the government has paved the way for subsequent private capitals. The innovation system of Israel is built based on the Yozma program implemented by the Office of Chief Scientist. Through the program, the government and private investors jointly set up collaborative funds, of which the government provides 40% of the capital, to help start-ups overcome financial limitations. The program has provided support to a lot of entrepreneurial start-ups and SMEs, laying a solid foundation for Israel’s venture capital industry, while creating large number of jobs and driving continuous economic growth. The mature venture capital environment in Israel created by its national innovation policies has stimulated the passion of local enterprises to pursue R&D, facilitated high-tech research in universities, and inspired entrepreneurship of the whole country.

The support from the government has given rise to venture capital in Israel. Total amount of venture capital in Israel reached USD4.5 billion in 2018, 1.31% of GDP, much higher than that in the US and Europe, ranking 2nd in the world. Investment of high-tech venture funds in Israel amounted to USD6.47 billion, up 17% from 2017, and more than twice of that in 2013. Venture capital mainly covers Fintech, cyber security, software, AI and other high-tech industries. 70% of the investment in Israeli start-ups comes from overseas, including the US, China, Germany and the UK, with VC companies in the US being the most active player.

Large-scale capital investment has significantly promoted the development and growth of Israeli companies. Now there are about 8,400 high-tech start-ups operating in Israel, and over 600 new companies are established every year, making Israel No.1 in the world by the number of start-ups per capita. Tel Aviv, Israel’s second largest city, is an emerging global entrepreneurial center. Israel ranks the 3rd by the number of companies listed on NASDAQ, following superpowers the US and China. As of 2019, Israel has six unicorns and 392 incubators and accelerators.

Thriving technological entrepreneurial activities in Israel have attracted investors and large multinational companies from the world. Over the past decades, more than 300 multinationals (including IBM, Google and Microsoft) have set up R&D centers in Israel, and some are even running multiple centers across different fields. These R&D centers account for 50% of the company’s R&D spending. Over the years, multinational companies running R&D centers in Israel have acquired more than 100 Israeli start-ups. Frequent acquisitions by multinational companies have provided inexhaustible power for Israel’s innovation ecosystem assets: leading technology, technologists, corporate culture, technology leadership and a sound ecosystem.
1.3.3 Germany: Stable and sustainable basis for innovation

As an established capitalist industrial power, Germany has always been in a key position in the European and world economic geography, with robust and strong momentum of economic development. Instead of stagnating in the glow of a manufacturing power, Germany has maintained high performances in innovation over the past decades.

In the global innovation system, Germany made itself back to the top 10 in 2016, and has remained in the 9th place ever since.\(^{25}\) In the global competitiveness rankings, the country ranks the third with a high score of 82.8, following the US and Singapore.\(^ {26}\) By virtue of its mature innovation ecosystem, Germany again becomes active in the forefront of global innovation. Its innovation capability is mainly manifested in two dimensions: intellectual property rights and enterprise investment and innovation, with especially outstanding performance in PCT patent applications, PPP publications and R&D spending. From the perspective of innovation inputs, R&D spending of Germany has maintained at a high level in recent years. In 2018, Germany's R&D spending accounted for 2.9% of its GDP, ranking the 10th globally. Germany ranks the third by the index of published scientific papers, following the US and the UK. Among over 120 economies, Germany has 295 patents per million population, ranking the 5th, and 8,457 international patent applications per million population, ranking the 12th.\(^ {27}\) As to education, three of the world's top 100 universities are based in Germany.\(^ {28}\)

Stability highlights Germany's path of innovation, with the government emphasizing on the consistency and systematicity of policy making to support entrepreneurship and innovation. In 1990, East and West Germany merged, and the federal government started to implement a package of innovation policies to promote economic development of the country. In 2004, the federal government signed a Research and Innovation Agreement with state governments to ensure sufficient research funding for major research institutions. From 2006, Germany started to provide comprehensive support for high-tech industry, and issued the High-Tech Strategy of Germany. In 2010, the German government issued the High-Tech Strategy 2020 for Germany, with increased funding for research to advance its 10 future scientific research programs and focus on globally oriented strategy making. In 2014, the new German government published the New High-Tech Strategy – Innovations for Germany, aiming to build Germany as a world-leading innovation country with priorities in smart transportation, smart services and other innovations related to digital economy and Industry 4.0.

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\(^{25}\) Based on the rankings of Global Innovation Index reports from 2016-2019
\(^{26}\) Global Competitiveness Report 2018
\(^{27}\) Global Competitiveness Report 2018
\(^{28}\) Based on QS World University Rankings 2020
In addition to strategic policies, Germany has already established an efficient scientific research and innovation system with clear division of labor as early as in the 1960s by pulling together the political, economic and social communities. Politically, the federal government and state governments act as policy guides and sponsors for scientific research, providing public funding for scientific research that accounts for one third of the country’s total R&D spending. The economic community contributes nearly two thirds of funding for research and innovation in Germany, mostly in application-oriented research programs. 80% of large corporations in Germany have their own independent R&D institutions.29 As to the social community, other than the role of universities as executers of scientific research, the most distinctive advantage of Germany is its four non-profit scientific research institutions (Max Plank Society, Helmholtz Association, Fraunhofer Society, and Leibniz Association), which are key bases of technological innovation in Germany. Moreover, the German society has well-developed interstitial organizations, such as chambers of commerce, foundations, and overseas federal agencies, which act as the glue for Germany. From top down, institutions at each level cooperate with each other with clear division of labor, working together for the smooth operation of the country’s innovation system.

Innovation sector in Germany has been growing rapidly over the past two decades, and it is now a thriving economic ecosystem. There were over 1,500 start-ups in Germany in 2018,30 and, as of 2019, Germany has given birth to 10 unicorns, mainly engaging in e-commerce, healthcare, tourism, automotive and transportation, Fintech, as well as data management and analytics.31 Over the past few years, investment by the government and venture capital firms in high-tech industry has been rising fast. Start-ups in Germany attracted public investment of USD3.5 billion in 2017, up 51% from 2016.32 Total investment by venture capital in Germany reached EUR4.4 billion in 2018, second only to the UK in Europe.33

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30 Europe Startup Monitor
31 CBINSIGHTS database
32 Crunchbase database
33 Annual European Venture Capital Report 2018, Dealroom.co
Chapter 2  An analysis of China's innovation ecosystem

The term "innovation ecosystem" refers to the stakeholders and resources necessary to achieve ongoing innovation in a modern economy. From the perspective of ecology, an array of factors such as enterprises and innovation atmosphere in the country are considered as a whole with a stronger focus on the interconnectedness and dependency among each innovation elements. This is the biggest difference between the innovation ecosystem and previous innovation theories. China's economic development has entered the high-quality growth stage with increased supply of innovation and strengthened construction of innovation environment, creating innovation ecosystem attractiveness favorable to the building of modern economic system.

2.1 Evaluation system for innovation ecosystems
An innovation ecosystem can be evaluated through three indicators. Firstly, innovation institutions reflect the number of innovation entities in a city and the strengths of the city in carrying out scientific and technological research and development (R&D) and business innovation. This includes innovation companies (e.g. high and new technology enterprises and the top 100 internet companies), unicorn companies and scientific research institutes. Secondly, innovation resources reflect whether the various elements of a city can adequately support innovation activities in innovation institutions. This includes innovation capital, innovation technologies and makerspaces. Thirdly, innovation environment reflects a city's ability to attract and retain outstanding innovation resources and create a sound external environment for aggregating innovation institutions. This includes innovation strategy, innovation foundation, innovation atmosphere and innovation cost; innovation foundation refers to the state of construction of intelligent infrastructure of the city, its economic competitiveness, and sustainability, and innovation atmosphere refers to the city's Internet+ atmosphere.

34China's Innovation Ecosystem, World Economic Forum
### Figure 15: Innovation ecosystem evaluation indicators

<table>
<thead>
<tr>
<th>Primary indicator</th>
<th>Secondary indicator</th>
<th>Implication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovation companies</td>
<td>The number of high and new technology companies in the city, the top 100 internet companies in China and the number of unicorn companies</td>
<td></td>
</tr>
<tr>
<td>Number of higher education institutions</td>
<td>Number of general higher education institutions in the city</td>
<td></td>
</tr>
<tr>
<td>Scientific research institutes</td>
<td>Number of state key laboratories in the city</td>
<td></td>
</tr>
<tr>
<td>Innovation talents</td>
<td>Percentage of AI talents among the total number of talents in the state</td>
<td></td>
</tr>
<tr>
<td>Innovation capital</td>
<td>Venture capital invested</td>
<td></td>
</tr>
<tr>
<td>Innovation technologies</td>
<td>Number of patent applications of the city</td>
<td></td>
</tr>
<tr>
<td>Makerspaces</td>
<td>Number of makerspaces registered with the state</td>
<td></td>
</tr>
<tr>
<td>Innovation strategy</td>
<td>Number of innovation policies from the government</td>
<td></td>
</tr>
<tr>
<td>Innovation foundation</td>
<td>The state of construction of intelligent infrastructure of the city, its economic competitiveness, and sustainability</td>
<td></td>
</tr>
<tr>
<td>Innovation atmosphere</td>
<td>The city’s Internet+ atmosphere</td>
<td></td>
</tr>
<tr>
<td>Innovation cost</td>
<td>Basic innovation cost faced by entrepreneurs including level of salary and office rental</td>
<td></td>
</tr>
</tbody>
</table>

Source: Deloitte Research
This paper selects 19 cities across the five major city clusters including the Beijing-Tianjin-Hebei region, the Yangtze River Delta region, the central region, the western Chengdu-Chongqing region and the Guangdong-Hong Kong-Macao Greater Bay Area. With the launch of a range of policies supporting the development of the new economy by the governments of the above cities, emerging industries have achieved remarkable development in recent years.

By setting up an innovation ecosystem evaluation system, this paper evaluated the innovation achievements and challenges of each city, in an effort to obtain a clear picture of the current state of development of China’s innovation ecosystem as well as the characteristics of development of the innovation ecosystems in the five major regions and their directions for future enhancement.

**Figure 16: Innovation ecosystem evaluation system and distribution of cities**

Source: Deloitte Research
2.2 The innovation ecosystems of each city demonstrated tiered development

In the rankings of China’s innovation ecosystems, cities were divided into three bands by the total scores they obtained. In Band 1, tier-one cities including Beijing, Shanghai, Shenzhen and Guangzhou remained among the leading positions, but Hangzhou surpassed Guangzhou to rank fourth. Nanjing, Chengdu and Wuhan were among the first in Band 2. In the third band were predominantly cities with remarkable achievements obtained by policy-driven innovation ecosystems, such as Dongguan, Foshan, Zhuhai and Guiyang.

Figure 17: Rankings of China’s innovation ecosystem

Source: Deloitte Research
In terms of innovation institutions, Beijing, Shanghai and Shenzhen ranked top three. Under the sub-indicator of innovation enterprise, the numbers of high and new technology enterprises owned by Beijing, Shanghai and Shenzhen were among the top in the country. Besides, these three cities were home to 60% of the top 100 internet companies in China, with 33% located in Beijing. In terms of unicorn companies, there were 162 unicorn companies in Beijing, Shanghai, Shenzhen and Hangzhou, accounting for 80% of the total number of unicorns in China, mainly because these four cities were home to BATJ-level innovation giants which incubated a huge amount of unicorns led by Alibaba and Tencent. In terms of scientific research institutes, Beijing had strong innovation foundation and sound innovation environment leveraging its higher education institutions and scientific research bodies.

Figure 18: Rankings of cities by innovation institutions

<table>
<thead>
<tr>
<th>Band 1</th>
<th>Beijing</th>
<th>Shanghai</th>
<th>Shenzhen</th>
<th>Hangzhou</th>
<th>Guangzhou</th>
</tr>
</thead>
<tbody>
<tr>
<td>Band 2</td>
<td>Nanjing</td>
<td>Chengdu</td>
<td>Tianjin</td>
<td>Wuhan</td>
<td>Suzhou</td>
</tr>
<tr>
<td>Band 3</td>
<td>Xi'an</td>
<td>Dongguan</td>
<td>Guiyang</td>
<td>Foshan</td>
<td>Zhengzhou</td>
</tr>
</tbody>
</table>

Source: Deloitte Research
In terms of innovation resources, Beijing, Shanghai and Shenzhen were among the top three, followed by Hangzhou, which rose to the fourth place. In respect of the sub-indicators, the four cities hosted over 55% of AI talents in China, with Beijing accounting for nearly 30%. In terms of innovation capital, Beijing and Shanghai became the cities with the most capital inflow in 2018, and Hangzhou surpassed Shenzhen to rank third. In terms of innovation technologies, Shenzhen and Beijing ranked first and second respectively, followed by Shanghai in the third place. In terms of makerspaces, Beijing and Shanghai had the most makerspaces registered with the state, accounting for nearly 20% of the total.

**Figure 19: Rankings of cities by innovation resources**

<table>
<thead>
<tr>
<th>Band</th>
<th>City</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Beijing</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Shanghai</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Shenzhen</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Hangzhou</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>Guangzhou</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>Nanjing</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>Chengdu</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>Suzhou</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>Wuhan</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Tianjin</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>Chongqing</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Xi’an</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>Zhengzhou</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Changsha</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>Dongguan</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>Zhuhai</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Hefei</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Foshan</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Guiyang</td>
<td>31</td>
</tr>
</tbody>
</table>

Source: Deloitte Research
In terms of innovation environment, Shenzhen, Guangzhou, Beijing and Shanghai were among the top four. These four cities had their respective advantages. Shenzhen ranked first in innovation atmosphere, leading far beyond other cities; the Guangzhou government is more focused on the construction of innovation environment by launching a range of policies driving innovation in 2018, making the city the first by number of policies; Beijing performed well in innovation foundation with great development potential in economy, topping the chart of construction of innovation infrastructure in China while increasing innovation cost of enterprises as a result of higher salary level and rentals.

Figure 20: Rankings of cities by innovation environment

<table>
<thead>
<tr>
<th>Band 1</th>
<th>Shenzhen</th>
<th>Guangzhou</th>
<th>Beijing</th>
<th>Shanghai</th>
</tr>
</thead>
<tbody>
<tr>
<td>Band 2</td>
<td>Wuhan</td>
<td>Chengdu</td>
<td>Chongqing</td>
<td>Suzhou</td>
</tr>
<tr>
<td>Band 3</td>
<td>Hangzhou</td>
<td>Dongguan</td>
<td>Changsha</td>
<td>Tianjin</td>
</tr>
<tr>
<td></td>
<td>Zhengzhou</td>
<td>Nanjing</td>
<td>Foshan</td>
<td>Xi’an</td>
</tr>
<tr>
<td></td>
<td>Hefei</td>
<td>Zhuhai</td>
<td>Guiyang</td>
<td></td>
</tr>
</tbody>
</table>

Source: Deloitte Research
From the above innovation ecosystems, we have the following findings:

**Aggregation of innovation entities in tier-one cities is more prominent.** This is because tier-one cities have brought together major enterprises with advanced technologies, making them the center for aggregation of technologies and resources in China. Leading enterprises are drivers for innovation-based start-ups, nurturing a number of innovation start-up enterprises. For example, in 2018, there were more than 1,300 start-ups led by Tencent. The number of Tencent-led start-ups in Shenzhen was significantly greater than that in Beijing and Shanghai, accounting for 32% of the total.

**There is a big gap between Band 3 and Band 1 cities.** This is because the stronger innovation resources are often drawn together. Tier-one cities with first-mover advantages have more advanced and large companies and higher levels of talents, capital and technology accumulation, resulting in continuous amassing of innovation resources. In Band 3 cities, innovation resources lag behind in development due to economic level and other factors, thus facing greater resistance in subsequent development. In respect of talents, for example, AI talents in China are unevenly distributed, mainly found in the Beijing-Tianjin-Hebei, Yangtze River Delta and Pearl River Delta regions. At the same time, the central and western regions have also aggregated a certain amount of talents, mainly along the coast of the Yangtze River. This is mainly because economically developed regions have aggregated many exceptional AI companies, and the salary level of AI talents is higher than other regions due to financial support from the government and society. However, the level of economic development and scale of economy have limited the expansion of innovation infrastructure and innovation investment in Band 3 cities.

**Each city’s innovation strategies are formulated based on its own level of economic development with different focuses.** In advanced regions, cities such as Beijing, Shanghai and Shenzhen build AI innovation system to promote research and commercial use of leading-edge technologies, develop whole industry chains and create application scenarios. Cities with certain level of industry foundation such as Chongqing focus on developing smart industry by integrating with advantaged industries such as the manufacturing industry, promote smart upgrade of industries with a focus on developing smart industries including AI, IoT and smart hardware, and promote the smart upgrade of traditionally advantaged industries such as manufacturing industry. Developing cities focus on a single area and create unique innovation ecosystems due to weaker technology and industry foundations. For example, Guizhou is building a big data whole industry chain covering technological R&D, data aggregation, mining, analysis, processing and application through the construction of the China Big Data Industry Innovation Pilot Zone. It also implemented the "cloud construction project" to promote the formation of big data cloud service industry clusters and construction of big data transaction centers.
2.3 The characteristics of innovation ecosystems in each region are distinct

On regional level, innovation ecosystems in China are distinct in characteristics: innovation development in the Beijing-Tianjin-Hebei region is centered in Beijing; the overall level of development in the Yangtze River Delta region is higher than other regions; the development in the Guangdong-Hong Kong-Macao Greater Bay Area is promising; the central and western regions are accelerating development.

In terms of development of the innovation ecosystem in the Beijing-Tianjin-Hebei region, Beijing has become the center of innovation ecosystem. The city dominated in innovation enterprises and innovation resources, and ranked among the top in innovation environment. In 2018, the number of invention patents per 10,000 persons in Beijing reached 111, ranking first among the state. As of 2019 Q1, there were 82 unicorn companies in Beijing. With the implementation of the city strategy on national scientific and technological innovation center, Beijing will achieve breakthroughs in leading-edge technologies such as quantum information, brain science and brain-like intelligence technology, and AI through the construction of world-class new research and development institutions in the future.

**Figure 22: Cities leading in various indicators**

<table>
<thead>
<tr>
<th>Innovation institutions</th>
<th>Beijing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovation companies</td>
<td>Beijing, Shanghai, Shenzhen, Guangzhou</td>
</tr>
<tr>
<td>Unicorn companies</td>
<td>Beijing, Shanghai, Hangzhou, Shenzhen</td>
</tr>
<tr>
<td>Scientific research institutes</td>
<td>Beijing, Shanghai, Wuhan, Nanjing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Innovation resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing</td>
</tr>
<tr>
<td>Innovation talents</td>
</tr>
<tr>
<td>Innovation capital</td>
</tr>
<tr>
<td>Innovation technologies</td>
</tr>
<tr>
<td>Makerspaces</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Innovation environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shenzhen</td>
</tr>
<tr>
<td>Innovation strategy</td>
</tr>
<tr>
<td>Innovation foundation</td>
</tr>
<tr>
<td>Innovation atmosphere</td>
</tr>
<tr>
<td>Innovation cost</td>
</tr>
</tbody>
</table>

Source: Deloitte Research
The level of comprehensive innovation in the Yangtze River Delta region is generally higher than other regions. Shanghai and Hangzhou have played a more significant role in driving innovation. Nanjing and Suzhou both ranked among Band 2 innovation cities. Specifically, Hangzhou began to rise with its remarkable performance, demonstrating significant aggregation of AI talents and influx of innovation capital. In 2019 Q1, the number of unicorn companies in Hangzhou surpassed that of Shenzhen. In 2018, the annual capital inflow exceeded RMB160 billion, surpassing Shenzhen.

Hangzhou:
- Unicorn companies: 19
- Top 100 Internet companies: 6
- AI talents: 6.5%
- Capital inflow: RMB160 billion

Its AI talents accounted for 6.5% of the total amount of talents in China.

Innovation development in the Guangdong-Hong Kong-Macao Greater Bay Area will be led by Guangzhou and Shenzhen. Guangzhou focuses on environment level and promotes the implementation of innovation by the government. In 2017, Guangzhou Municipal Government began to promote the IAB strategy (next-generation information technology, AI and biomedicine), which aims to upgrade the manufacturing industry. Guangzhou Pharmaceutical Holdings and iFlytek officially entered into a strategic cooperation agreement to explore the new mode of development by integrating pharmaceutical and intelligence and create a smart healthcare system together. Guangzhou Baiyun District Government and Huawei entered into a cloud industry strategic cooperation agreement to create a next-generation information industry cluster. In terms of application, Shenzhen is more competitive, with conglomerates such as Tencent, and deployment in the foundation layer, technology layer and application layer of AI. Meanwhile, Shenzhen offered a number of application scenarios and aggregated a range of innovation enterprises covering robotics, mobile phone, disease screening, finance and other areas.

Dongguan, Foshan and Zhuhai are relatively weaker in innovation advantages, but their future development is promising. With progress in the construction of the Guangdong-Hong Kong-Macao Greater Bay Area, Dongguan and Foshan will take on some of the companies that moved out from Shenzhen. Meanwhile, by leveraging the existing robust foundation of the manufacturing industry, these cities will make their presence felt in the development of the innovation ecosystem in the Guangdong-Hong Kong-Macao Greater Bay Area in the future.

Figure 23: Innovation in Hangzhou

Source: Deloitte Research
Driven by policies, core cities in the central and western regions enjoyed rapid development in innovation ecosystems. The high and new technology industry in the core cities in the central and western regions is undergoing the rising phase of development. A complete industry chain and innovation ecosystem are being formed, and the size of the internal market is not sufficiently large. However, leveraging policies on household registration, taxation and others, the innovation environment of these cities has been optimized, attracting companies and talents. In particular, the central government has rolled out policies strongly inclining towards the central and western regions to promote rapid development of the innovation ecosystem, creating a trend to catch up with Band 1 cities by these cities. Chengdu and Wuhan are known as the core area for innovation ecosystem development in the western Chengdu-Chongqing region and central region respectively. Chengdu’s “Rongpiaox” Project (Chengdu Drifters) and the “Twelve New Rules with respect to Talent Development in Chengdu” have further highlighted the aggregation effect of high-level innovation talent. Donghu New Technology Development Zone has become a key driver of innovation in Wuhan. In 2018, the number of high and new technology companies in Donghu New Technology Development Zone reached 2,306, ranking fourth among new technology development zones in China. It has fostered over 2,000 Internet+ companies, more than 40 of which have raised over RMB100 million.

Figure 24: Complementary advantages of the Guangdong-Hong Kong-Macao Greater Bay Area cities in the development of the innovation ecosystem

<table>
<thead>
<tr>
<th>City</th>
<th>Solid manufacturing foundation and great potential of integration</th>
<th>Strong aggregation of resources (policy, funds, companies)</th>
<th>With AI-focused enterprises and plenty of start-ups</th>
<th>Strong R&amp;D capability</th>
<th>Provide plenty of application scenarios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dongguan</td>
<td>Yes</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Guangzhou</td>
<td>Yes</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Foshan</td>
<td>Yes</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Shenzhen</td>
<td>Yes</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Source: Deloitte Research

Figure 25: Rankings of cities in the central and western regions by innovation ecosystem

<table>
<thead>
<tr>
<th>City</th>
<th>Overall</th>
<th>Innovation institutions</th>
<th>Innovation resources</th>
<th>Innovation environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chengdu</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wuhan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chongqing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changsha</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xi’an</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zhengzhou</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guiyang</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Deloitte Research
Chapter 3 Characteristics of development of leading industries in China's innovation

3.1 AI develops with a high level of penetration
1. China's AI industry develops rapidly

The global AI market will experience phenomenal growth in the coming few years. Gartner predicts that the global AI market will exceed USD5 trillion by 2025 and the compound annual growth rate for 2017-2025 will reach 128%. China is one of the world's most active countries in application of AI technology. AI technology has been gradually applied in various industries since it was put into commercial application in 2015. Its development prospect is widely recognized by different sectors including governments and businesses. It has undoubtedly become a key influencer on China's economic development. In 2018, the total size of investment and financing in AI in China reached RMB131.1 billion, with 597 financing deals. As of 2018, the total amount of investment and financing in AI in China accounted for 60% of the global total.

2. The effect of businesses aggregation is strong with shared supporting resources

A vast industry and solution market is a major advantage for AI development in China. Such advantage is composed of the market advantage brought by the massive search data, extensive product lines, and wide range of industries, as well as the promotion of open source technology communities by domestic and foreign technology giants, which helps start-ups in the AI application layer break through technological barriers and apply AI directly in R&D in the end product layer. In terms of industry, AI has been vertically applied in various sectors including medical and healthcare, finance, education, and security. Given such vast market spaces, Chinese AI companies continue to emerge. In addition, to promote industry upgrade and replace old economic drivers with new ones, local governments across China have begun to issue industry planning guiding opinions related to the AI industry, and offer tax incentives, subsidies, talent introduction and efficient administrative procedures to enhance business environment and attract competitive enterprises. These contribute to the significant effect of aggregation of AI companies in China.

Figure 26: Changes in investment and financing in AI

Source: Public information, Deloitte Research
Driven by the dual forces of policy and capital, the number of AI companies rises rapidly. According to incomplete statistics, the number of AI companies across China exceeded 4,000. Most of these companies are located in the Beijing-Tianjin-Hebei region, Pearl River Delta region and Yangtze River Delta region. Meanwhile, with the need of a large number of traditional manufacturing players to use the AI technology for intelligent upgrade and the support of government policies, the western Sichuan-Chongqing region has become an area for aggregation of AI companies. In terms of city, Beijing, Shanghai, Shenzhen and Hangzhou are cities with the largest number of AI companies, all exceeding 90, ranked in Band 1. The effect of aggregation of companies enables the gradual formation of the AI industry chain in China as well as the initial formation of characterized AI industry clusters in regions including the Yangtze River Delta region, Pearl River Delta region and Beijing-Tianjin-Hebei region.

Source: Public information, Deloitte Research

Figure 27: Distribution of AI companies in China

Source: China AI Development Report 2018, Tsinghua University
3. Scientific research institutes provide strong support to AI
As the AI technology continues to advance, the spillover benefits of the core basic technology are enhanced. In terms of algorithm, the deep learning algorithm has advantages in the processing of massive data using different types of deep neural networks. Their continuous application in areas including computer vision and image recognition, and voice recognition, will continue to transform the traditional computer algorithm frameworks. In terms of computing power, heterogeneous computing models adopting CPU+X such as FPGA, FPU and ASIC can basically meet the requirements for faster, more efficient, and more convenient use of processors. In terms of data, the number of IoT connected devices and hyper-scale data centers worldwide will reach 20.4 billion and 485 respectively by 2020. With the broadening application of distributed network transmission architecture, accelerated commercialization of 5G and rapid development of wearable devices and intelligent connected vehicles, the abilities to sense, acquire, transmit, analyze and store large-scale structured data have made a leap.

At present, China’s computer vision, intelligent voice semantic processing, intelligent robots, intelligent driving, and consumer drones will be in the forefront internationally, with an outburst of application opportunities for intelligent connected vehicles, intelligent service robots and intelligent drones.

Scientific research institutes and bodies are important places for the research and development of the AI technology. Since 2014, the amount of AI papers in China has surpassed the United States, and far exceeded other countries. This is closely tied to the rapid development of scientific research institutes and bodies in AI. Meanwhile, scientific research institutes and bodies also serve as the major driver of AI patent applications. Therefore, analyzing the AI scientific research institutes and bodies in each city will help understand the technological power of such city.
Figure 28: Characteristics of AI scientific research institutes and bodies in each city

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Scientific research institutes</th>
<th>Government or scientific research bodies and institute laboratories</th>
<th>Enterprise laboratories</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Beijing</strong></td>
<td>Host more than 50% nationwide:</td>
<td>More than 10:</td>
<td>• 360</td>
</tr>
<tr>
<td></td>
<td>• Tsinghua University</td>
<td>State Key Laboratory of Pattern Recognition</td>
<td>• Sinovation Ventures</td>
</tr>
<tr>
<td></td>
<td>• Peking University</td>
<td>State Key Laboratory of Intelligent Technology and Systems</td>
<td>• Jinri Toutiao</td>
</tr>
<tr>
<td></td>
<td>• Beihang University</td>
<td>State Key Laboratory of Deep Learning Technology and Application</td>
<td>• Lenovo</td>
</tr>
<tr>
<td></td>
<td>• Institute of Automation, Chinese Academy of Sciences</td>
<td>Institute for Artificial Intelligence, Tsinghua University</td>
<td>• UBTECH</td>
</tr>
<tr>
<td></td>
<td>• Various higher education institutions:</td>
<td>Law and Artificial Intelligence Laboratory, Peking University</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Shanghai Jiao Tong University</td>
<td></td>
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<tr>
<td></td>
<td>• Fudan University</td>
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<td></td>
<td>• Shanghai Tongji University</td>
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<td></td>
</tr>
<tr>
<td><strong>Shanghai</strong></td>
<td>Various higher education institutions:</td>
<td>SJTU-Versa Computer Science and AI Joint Lab</td>
<td>• SAIC Motor</td>
</tr>
<tr>
<td></td>
<td>• Shanghai Jiao Tong University</td>
<td>Parallel AI Adaptive Learning Joint Laboratory jointly established by Institute of Automation of Chinese Academy of Sciences and Squirrel AI</td>
<td>• Philips</td>
</tr>
<tr>
<td></td>
<td>• Fudan University</td>
<td></td>
<td>• SenseTime</td>
</tr>
<tr>
<td></td>
<td>• Shanghai Tongji University</td>
<td></td>
<td>• Microsoft</td>
</tr>
<tr>
<td><strong>Shenzhen</strong></td>
<td>Mainly government driven:</td>
<td>Shenzhen Academy of Robotics</td>
<td>• Tencent</td>
</tr>
<tr>
<td></td>
<td>• Shenzhen University</td>
<td>Shenzhen Institute of Artificial Intelligence and Big Data</td>
<td>• Huawei</td>
</tr>
<tr>
<td></td>
<td>• Southern University of Science and Technology</td>
<td></td>
<td>• ZTE</td>
</tr>
<tr>
<td><strong>Hangzhou</strong></td>
<td>Still lags behind Beijing, Shanghai and Shenzhen</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Zhejiang University</td>
<td></td>
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</tr>
</tbody>
</table>

Source: Public information, Deloitte Research
The above four cities have their own characteristics in terms of AI institutes and bodies. Beijing has the strongest scientific research strength, hosting more than 50% of scientific research institutes nationwide and over 10 national laboratories. Meanwhile, internet giants including Baidu, JD.com and Meituan have set up their enterprise laboratories in Beijing, investing huge social capital in the research and development of AI. Shanghai leverages the premium resources of higher education institutions including Fudan University, Tongji University and Shanghai jiao Tong University, ranking among the top nationwide in terms of AI strength. Shenzhen has a large number of technology companies, making its presence felt in the AI technology by leveraging the strengths of leading enterprises including Tencent, Huawei, and ZTE. Meanwhile, the government is playing its role by building the Shenzhen Academy of Robotics and Shenzhen Institute of Artificial Intelligence and Big Data to further enhance technological strengths. Hangzhou still lags behind Beijing and Shanghai in terms of the number of institutes, institute laboratories and enterprise laboratories. It mainly relies on internet giant Alibaba in conducting AI research.

**AI company example: SenseTime**

SenseTime is a leader in artificial intelligence in China, principally engaging in computer vision technology and deep learning algorithms. It is an algorithm provider in computer vision and deep learning, and also a new generation of open innovation platform of artificial intelligence designated by the Ministry of Science and Technology of China. As a world’s leading AI platform company, SenseTime succeeds in establishing an innovation ecosystem in AI sector for the following four reasons.

1. **Boast deep talent reserve and leading original technological strengths**

   As a technology giant, SenseTime relies on talents and technological strengths to drive its development, enabling it to differentiate itself from and win over its competitors in the market. Gasping the opportunity of talent training and acquiring the world’s top talents from the source, SenseTime boasts an Asian leading deep learning team, whose core has 20 years of scientific research experience. At present, the company has more than 3,000 employees, 200 of whom have gained their Ph.D. degree from top universities. Moreover, SenseTime has maintained close cooperation with global academic community. In September 2018, SenseTime together with MIT, Shanghai Jiao Tong University and other universities, initiated the Global University Artificial Intelligence Academic Alliance to promote international academic exchanges and talent cultivation, stimulating the long-term development of artificial intelligence research and technology. In China, SenseTime has jointly established labs or developed scientific research with the Chinese University of Hong Kong, Tsinghua University, Peking University, Shanghai jiao Tong University and Zhejiang University.

2. **Enable multi-industries commercially and establish industrial chain collaboration mechanism**

   SenseParrots, an original deep learning platform independently developed by SenseTime, has more advantages in supporting super-deep network scale, super-large data learning and complex related applications. SenseTime uses its deep learning platform to promote industrial upgrading and build artificial intelligence ecology. In recent years, various computer
vision technologies of SenseTime have been rapidly applied in numerous industries. It has explored its unique model, "1 (basic research) + 1 (product and solution) + X (industries)”, to drive and enable hundreds of industries, and has successfully occupied the first place in the market share of many vertical areas. In terms of smart city industry, SenseTime promotes the application of face recognition and intelligent video analysis technology. In the field of smart retail, it helps traditional retail enterprises to enhance users' shopping experience, improve the operation of retail enterprises, and achieve precision marketing. In the mobile phone industry, it provides technologies including facial unlocking, smart beauty, smart filters, background blur and smart photo albums for well-known mobile phone brands to comprehensively enhance user experience. Currently SenseTime is working with over 700 world-renowned domestic and overseas companies and institutions, and provides them with complete solutions based on face recognition, image recognition, video analysis, autonomous driving, medical image recognition and other artificial intelligence technologies. Only by enabling and commercializing AI technology in various industry, can SenseTime gain sustainable development. The ability of commercialized landing is also the competitive advantage of SenseTime in leading the industry. In addition to developing AI technology independently, it is also committed to establishing industrial chain collaboration mechanism by investing in companies with industrial value or vertical integration with itself. For example, 51 VR is invested in AR and VR applications, and Terminus is invested in security. Thus, AI applications are expanded.

3. Establish cooperation relationship with the government, promote aggregation of the technology and innovation industry, and leverage the opportunities brought by the state’s strategies and policies

In September 2018, China's Ministry of Science and Technology announced that SenseTime would build the National Open Innovation Platform for Next Generation Artificial Intelligence on Intelligent Vision, becoming the fifth national AI open innovation platform after Alibaba, Tencent, Baidu and iFlytek with its strong computer vision and deep learning technologies. In addition, SenseTime has also become a leading force in the development of the new technology and innovation center in the Guangdong-Hong Kong-Macao Greater Bay Area and promotion of the global layout of technology.

4. Recognized by the capital market with access to sufficient financing to support development of innovative technologies

SenseTime is an AI tech unicorn with the largest sum of funds raised and highest valuation in the capital market. It has raised record funds of USD400 million and USD600 million, and is valued at USD4.5 billion in only four years since it was established. These funding serves as solid foundation for independent R&D and industry integration. SenseTime will expand overseas markets and increase investment in emerging areas, including smart medical treatment and robots. It will strengthen the advantages of science and technology platform and attract more and more artificial intelligence business ecology driven by itself.
3.2 Autonomous driving sees emerging opportunities

1. Autonomous driving exhibits opportunities and vitality

Autonomous driving, a high-level automated driving technology, is a product resulted from the deep application of the AI technology in the car industry. It has epoch-making revolutionary significance. In recent years, with advances in the AI technology, innovation entities continue to devote efforts in the autonomous driving market. They form a joint force with other players in the field globally, promoting the growth and expansion of the market. As estimated by Qianzhan Industry Research Institute, the global market for autonomous driving market will worth hundreds of billions of dollars by 2020; China will play an important part in the autonomous driving market with its strong growth momentum in recent years. The future of the autonomous driving market is promising.

In China’s innovation ecosystem, autonomous driving exhibits development opportunities and vitality. According to the Technology Roadmap for Energy Saving and New Energy Vehicles published by China Society of Automotive Engineers, the number of intelligent vehicles in China will reach 15 million by 2020. In respect of commercial use, China has taken the lead in putting autonomous cleaning trucks, autonomous electric trucks and autonomous express delivery vehicles into use. In respect of technological R&D, although China’s autonomous driving still lags behind the world’s advanced level, there are some outstanding players in the industry, such as Baidu-BAIC, which are highly competitive in the global autonomous driving market.

Figure 29: Size of the Chinese autonomous driving market in 2014-2018 (RMB100 million)

Source: Qianzhan Industry Research Institute, Deloitte Research

The ultimate goal of autonomous driving is to achieve real autonomy, which enables passengers to do other activities in addition to paying attention to road conditions. Nevertheless, the process of replacing cars with autonomous vehicles is long and progressive, and consideration must first be given to how autonomous vehicles and human drivers coexist. In the current progress of development, there are still many problems and challenges to be addressed from the road test stage to pilot application stage.
2. Aggregation of the automobile industry allows complementation of premium resources

China’s autonomous driving industry has formed an innovation ecosystem involving strong alliance and collaboration between the traditional automobile companies and internet companies. Traditional automobile companies may manufacture autonomous vehicles at a lower cost but on a larger scale for internet companies, and use sophisticated automobile manufacturing technologies to enable internet companies to implement the technologies they developed and gain practical data and experience. Internet companies may help traditional automobile companies in transformation and upgrade, accelerating their application of autonomous driving technologies and launching of autonomous cars.

For instance, Changan Automobile is cooperating with Baidu, Ali and Intel, with a plan to achieve a product portfolio share of 10% for autonomous vehicles by 2020 and realize the operation of autonomous vehicles by 2025; BAIC is cooperating with Baidu and Robert Bosch with a plan to deploy autonomous driving and intelligent connection technologies in all car models by 2020; Geely, GWM, and Chery are cooperating with internet companies respectively to launch autonomous car models; among foreign traditional automobile companies, BMW also joins hands with Tencent to build an autonomous driving research and development center in Shanghai, which will be their sole autonomous driving R&D center overseas. Given such close cooperation and complementary advantages, many current players in the autonomous industry hope to set up their core innovation departments in where the automobile industry and internet industry aggregate to take better part in market cooperation. Therefore, Beijing, Shanghai and Shenzhen are widely favored by companies engaging in innovation of the autonomous driving technology.

Many autonomous driving start-ups tend to set up their headquarters in Suzhou, Nanjing, Tianjin and Changsha. However, their R&D centers are predominantly located in major tier-one cities including Beijing, Shanghai and Shenzhen. Such significant advantage is primarily derived from collaboration between industries relying on talents and technological resources from higher education institutions and those relying on industry chains.

Figure 30: Locations of R&D centers of major autonomous driving start-ups in China (by city)
From the perspective of innovation entities, there are two main types of innovation entities in autonomous driving in China: higher education institutions and companies. Higher education institutions offer companies with proactive technological guidance and sufficient talent resources. Indeed, a lot of autonomous driving start-ups were incubated from student teams or laboratories. Many higher education institutions and research bodies have dedicated laboratories and R&D teams related to intelligent vehicles. Some higher education institutions have also established cooperation relationship with the industry and have obtained remarkable achievements in autonomous driving. For example, as reflected in the China Intelligent Vehicles Future Challenge, a contest of the highest level and largest scale in autonomous driving in China, the better-performed higher education institutions and research bodies in recent years were mainly located in Beijing, Shanghai and Suzhou. This highly echoes the establishment locations of R&D centers.

**Figure 31: Awardees of China Intelligent Vehicles Future Challenge in recent years and their respective locations**

<table>
<thead>
<tr>
<th>City</th>
<th>Awardee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing</td>
<td>Beijing Union University, Institute of Automation of Chinese Academy of Sciences, Beijing Institute of Technology, Beihang University</td>
</tr>
<tr>
<td>Shanghai</td>
<td>Shanghai Jiao Tong University, Tongji University</td>
</tr>
<tr>
<td>Suzhou</td>
<td>Suzhou Automotive Research Institute of Tsinghua University, Suzhou Vocational University</td>
</tr>
<tr>
<td>Nanjing</td>
<td>Nanjing University of Science &amp; Technology</td>
</tr>
<tr>
<td>Zhenjiang</td>
<td>Jiangsu University</td>
</tr>
<tr>
<td>Xiamen</td>
<td>Xiamen University</td>
</tr>
<tr>
<td>Wuhan</td>
<td>Wuhan University</td>
</tr>
<tr>
<td>Changsha</td>
<td>National University of Defense Technology</td>
</tr>
<tr>
<td>Xi’an</td>
<td>Xi’an Jiaotong University</td>
</tr>
</tbody>
</table>

Source: Public information, Deloitte Research

**3. Autonomous driving application scenarios are gradually extended**

Industry experts predict that from 2019 to 2020, autonomous driving L3 (conditional automatic) vehicles will achieve mass production, and after 2022, some enterprises will achieve L4 (highly automatic) mass production, and the fastest time to achieve L5 (fully automatic) mass production is 2028. The difficulty of autonomous driving in different scenarios is different. For some scenarios with relatively single traffic environment, autonomous driving may land commercially in a short time. At this stage, the application of autonomous driving technology can be extended to logistics, public transport, port and dock, shared mobility, park, sanitation, mining, retail and other low-speed and limited scenarios.
### Logistics

The development of intelligent logistics has broad prospects, and major enterprises are competing for layout. The core of logistics is scheduling, and that of the intermediate transportation link is safety and costs. With the help of autonomous driving technology, logistics such as loading, unloading, transportation, receiving and warehousing will gradually become unmanned and machined, stimulating the logistics industry to reduce costs and increase efficiency and promoting the innovation and upgrading of the industry. On July 4, 2018, Baidu, together with Neolix, released the L4-class mass produced unmanned logistics vehicle - "Neolix AX1", and took the lead in trial operation in Changzhou and Xiong’an. On November 7, 2018, IDRIVERPLUS announced that its unmanned logistics and distribution vehicle "Wobida" has entered the stage of mass production. The vehicle is mainly used for unmanned logistics distribution in residential areas or parks.

### Public Transportation

Bus has met the basic standard of autonomous driving because of its slow speed, short distance, fixed route and bus lane. Autonomous driving system applied to buses can react to emergencies in time, able to detect pedestrians and other vehicles, slow down and avoid cars, stop the bus under emergencies, pass round obstacles and autonomously stop at the station. On January 22, 2019, the first autonomous driving bus in Shandong, which was a L4 unmanned intelligent trial vehicle designed by China Heavy Truck R&D Center, was applied into use. On January 18, 2019, the Panda Intelligent Bus, which was developed by Deepblue, was officially launched at the Summit on the Future Development of New Generation Artificial Intelligence. It has been tested in Deyang, Changzhou, Quzhou and Chizhou.

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**Figure 32: Autonomous driving application scenarios**

<table>
<thead>
<tr>
<th>Logistics</th>
<th>Public Transportation</th>
<th>Shared Mobility</th>
<th>Sanitation</th>
<th>Park</th>
<th>Ports and Docks</th>
</tr>
</thead>
<tbody>
<tr>
<td>APOLLO, UISEE, VIPioneers, RoadStar, Haylion, Smarter Eye, Plus AI, TuSimple, CCIV, Jingchi, CHJ Automotive, NAVINFO, IN-Driving, IDRIVERPLUS, Neolix, HOLOMATIC, Leadgen, CIDI</td>
<td>APOLLO, MAXIEYE, UISEE, TSINTEL, Horizon Robotics, Roaddefend, IN-Driving, Leadgen, CowaRobot, JIMU, Haylion, Jingchi, HOLOMATIC, Kuandeng</td>
<td>Momenta, LEAP MOTOR, Shouqi Limousine &amp; Chauffeur, Meituan taxi, Didi tax, Caocao, HOLOMATIC, Jingchi</td>
<td>APOLLO, Zongmu, Leadgen, Qingfei, Jingchi, CCIV, IN-Driving, CowaRobot</td>
<td>APOLLO, WESTWELL, UISEE, Plus AI, TAGE, Leadgen, HOLOMATIC, Kuandeng, Qingfei</td>
<td></td>
</tr>
</tbody>
</table>
• Ports and docks
China boasts numerous ports, where a large volume of cargo is handled each year, demonstrating a huge demand for truck drivers. The only way for these ports to keep pace with those world first-class ones is to realize the automation of horizontal container transportation with economically feasible schemes. The application of autonomous driving technology in ports and docks can effectively solve the problems of inaccurate driving line, blind sight area caused by turning and fatigue driving of drivers, and save labor costs. At present, many domestic ports have taken a key step. On April 19, 2018, FAW Jiefang released the ICV (intelligent container) specially designed for port operation. This is the first intelligent driving vehicle in China that realizes L4 class port demonstration operation. In addition, the ports of Qingdao, Xiamen, Tianjin and other cities took the lead in launching the unmanned and automated application, becoming the high-tech automated port. With the active layout of Internet companies and automobile companies, and the emergence of autonomous driving technology start-ups, the domestic strength in the field of autonomous driving is growing. In the future, with the development and evolution of environmental awareness, navigation and positioning, path planning, decision-making control and other technologies, the commercial landing of autonomous driving technology products will gradually move forward from low-speed to high-speed and from closed to open.
4. Local governments roll out supportive policies, and the central and western regions begin to thrive

The autonomous driving industry has been strongly supported by the central government and many local governments. Firstly, the Chinese government has created a sound environment for autonomous driving innovation in respect of development plans and approaches. Autonomous driving is regarded as a key transformation approach for the automobile industry by the state. In 2017, the National Development and Reform Commission (NDRC), the Ministry of Science and Technology, and the Ministry of Industry and Information Technology issued the Medium- and Long-term Development Plan of the Automobile Industry, stating that autonomous driving will be the focus of AI development in the coming decade in China. In 2018, the Ministry of Industry and Information Technology issued the Action Plan for the Development of the Internet of Vehicles (IoV) Industry, reiterating the goals including "driving leaping development of the IoV industry through continuous efforts after 2020", and "gradual mass commercialization of high-level autonomous intelligent connected vehicles and 5G-V2X". In many other occasions, the NDRC, the Ministry of Transport, and the Ministry of Science and Technology have stated that they will drive the development of the IoV industry and autonomous driving.

Secondly, many local governments have rolled out policies to facilitate development of the autonomous driving industry. It is particularly noteworthy that governments nationwide are relatively equal in terms of the support given to autonomous driving innovation; the governments of tier-one cities are not particularly advantageous. Currently, 18 cities have rolled out policies related to testing of autonomous driving to designate intelligent driving test areas and issue test licences for autonomous driving companies.

Figure 33: Proportion of number of road test licences for autonomous driving in different cities (as of 2019 H1)

These cities are mainly located in the developed eastern region. However, in the central and western region, Changsha and Chongqing have demonstrated strong enthusiasm in autonomous driving. Indeed, the sum of licences issued in both cities accounted for over one-third (36%) of the total number of road test licences issued. Furthermore, Changsha became the first autonomous driving city in the world in 2019.
3.3 Advanced manufacturing to reduce costs and improve efficiency

1. China’s smart manufacturing products and services’ profitability is improving significantly

Smart manufacturing covers the whole product life cycle and aims to realize information-based manufacturing under ambient ubiquity conditions. Based on advanced technologies such as modern sensing technology, Internet technology, automation technology and personified intelligent technologies, smart manufacturing technology uses intelligent sensing, human-machine interaction as well as decision making and execution technologies to realize intelligent design and manufacturing, which is the deep integration of IT, intelligent technology and equipment manufacturing technology. It updates the concept of manufacturing automation and makes it flexible, intelligent and highly integrated.

The Chinese government publishes Made in China 2025 in 2015 to clarify the priority of smart manufacturing. Through strengthening top-level design, establishing pilots and demonstration areas, constructing standard systems and cultivating system solution providers, the development of smart manufacturing has produced remarkable results, ushering in a period of rapid growth. The growth of smart manufacturing in China is manifested in three main aspects. First, Chinese industrial enterprises have benefited from a higher level of digital capacity and quality, laying a strong foundation for the future analysis, prediction and self-adaptation of manufacturing systems. Second, in terms of financial benefits, smart manufacturing is making a much greater contribution to corporate profitability. Third, in terms of typical applications, China has become the largest consumer of industrial robots, supported by fast-growing demand.

With the integration of IT and industrialization in China and the development of the industrial IoT, among other initiatives, manufacturers have made massive improvements to their digital capacity and quality, with the majority now focusing on vertical integration of data. As revealed in the Deloitte survey, 81% of respondents have completed computerization. Of these enterprises, 41% are in the connectivity stage, 28% are in the visualization stage and 9% are in the transparency stage. Enterprises in the prediction stage and self-adaptation stage each account for 2%.

Figure 34: The industry 4.0 progress of enterprises (self-assessment)

What stage is your enterprise at?

Source: Deloitte Smart Manufacturing Enterprise Survey 2018, Deloitte Research
China has become the world’s largest robot market and maintained rapid growth since 2013. China’s robot sales exceeded the total amount of the US and Europe in 2017. The Chinese market for industrial robots was valued at USD4.2 billion in 2017, or 27% of the global market, and will expand to USD5.9 billion by 2020. According to data from the International Federation of Robotics (IFR), Robot sales are expected to reach 160,000, 195,000 and 238,000 units in China in 2018, 2019 and 2020 respectively, representing a CAGR of 22%. Automotive, advanced equipment manufacturing, and electronics and electrical appliances remain the major users of industrial robots.

Upgrading to industry 4.0 brings real and visible benefits to manufacturers. In a Deloitte survey, if 200 manufacturers across the country in 2013, smart manufacturing in China was found to be in its infancy, generating meagre margins. However, after five years of rapid development, the ability of smart manufacturing to produce profitable products and services has risen sharply.

The profits brought to enterprises by smart manufacturing were not obvious in 2013 when 55% of surveyed businesses reported a contribution of 0%-10% to net profit through products and services derived from smart manufacturing. In comparison, only 11% of respondents in 2017 reported a profit contribution in this range, whereas 41% reported a profit contribution of 11%-30%. As a percentage of respondents, enterprises reporting a profit contribution of more than 50% rose from 14% in 2013 to 33% in 2017. The profit contribution of smart manufacturing has risen markedly, a result of increased production efficiency and higher value products and services.

Figure 35: Smart manufacturing products and services are making a much larger contribution to profits

<table>
<thead>
<tr>
<th>Profit contribution of smart manufacturing</th>
<th>2017</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–10%</td>
<td>11%</td>
<td>55%</td>
</tr>
<tr>
<td>11–30%</td>
<td>41%</td>
<td>14%</td>
</tr>
<tr>
<td>31–50%</td>
<td>14%</td>
<td>9%</td>
</tr>
<tr>
<td>51–80%</td>
<td>19%</td>
<td>9%</td>
</tr>
<tr>
<td>81–100%</td>
<td>14%</td>
<td>5%</td>
</tr>
</tbody>
</table>

Source: Deloitte Smart Manufacturing Enterprise Survey 2018, Deloitte Research
2. Smart manufacturing ecosystem can’t go without in-depth user value extraction

The ecosystem is well-developed. Amid growing market competition and increasingly transparent product pricing, manufacturers have little alternative but to seek new sources of value. Extracting value from equipment is manufacturers’ lifeblood. For example, R&D design incorporates new technology to produce smarter or more diversified products. At the sales stage, equipment-related financial services can be provided. After sales, data on equipment and products shipped from the factory are collected and monitored in real-time. Performance analysis and predictive maintenance can then improve security and create more service opportunities for the enterprise. Therefore, smart manufacturing ecosystem requires the participation of tech intelligent product companies, financial service companies, data collection and analysis companies.

China has developed complete manufacturing-supporting industries; they can help manufacturing enterprises achieve greater progress in intelligence upgrading.

Technology drives manufacturing. Smart manufacturing enterprises can be divided into two categories. First, it is the enterprises engaged in emerging technology innovation. They focus on the research of professional technologies in segments and provide equipment and technology services for manufacturing enterprises. Second is the traditional manufacturing enterprises, which boast manufacturing background, proprietary products or solid technological foundation. These enterprises keep up with the development trend of smart manufacturing in the new era and independently develop or introduce smart manufacturing technologies to improve efficiency, reduce costs and complete transformation and upgrading. Collaboration between the two categories of enterprises can maximize benefits, providing practical technology application scenarios, helping manufacturing enterprises realize transformation and upgrading and increase output. For example, Xiaomi includes Changhong into its smart manufacturing ecosystem chain to promote R&D and mass production of intelligent air conditioner products with Changhong's strong manufacturing capabilities and advanced technologies. Changhong and Xiaomi establish a joint lab to redefine the appearance, structure and circuit of air conditioner and build new production lines based on Changhong's existing air conditioner production capabilities to guarantee the production of Xiaomi's intelligent air conditioners. Such collaboration significantly improves production efficiency and corporate revenues.

Talent supply is abundant. Since industrial robot field has high professional technology requirements, universities and scientific research institutions are playing important roles. Many business founders and experts are from universities and scientific research institutions. The industrial planning of Anhui provincial government suggests to encourage talents from domestic and overseas universities to establish industrial technology institutes in strategic emerging industry clusters such as Hefei, Wuhu and Maanshan. Xi’an also proposes to fully tap talent resources, scientific research facilities and achievements of local universities including Xi’an Transportation University and Northwest Industrial University and introduce more talents to develop industrial robots. Moreover, many enterprises also team up with universities to research smart manufacturing technologies and applications. It can be seen that university talents and technology resources are crucial for the development of industrial robots. For instance, Xiaomi introduces innovation activities into universities by organizing National Collegian Programming Contest since 2018 and invests tens of million yuan to establish a joint AI lab with Wuhan University, with an attempt to find more talents and technologies for innovative development of smart manufacturing.
Domestic advantages increase. Domestic industrial robot segment maintains stable growth and domestic industrial robot sales in 2016 to 2018 is narrowing the gap with overseas brands. However, the sales of industrial robot sales of foreign brands experienced significant decline in 2018, with less market shares. This is because with the globalization of mainstream core industrial robot component suppliers, the price, cost and quality gaps between domestic and foreign industrial robots are narrowing. In terms of software algorithm, although the gap still exists, some domestic robot enterprises are making technological progress constantly, breaking the technology monopoly of foreign brands. For example, China overcame technical difficulties in developing high performance control systems in 2017. The motion system technology owned by large foreign robot enterprises such as ABB was firstly mastered by Pokae in 2017, making industrial robots more precise, rapid and stable, and this effectively improves the competitiveness of domestic industrial robots. Moreover, based on various advantages such as lower costs and emphasis on client services, domestic industrial robots have become the optimal choice. Therefore the market share of domestic industrial robots improves constantly.
3. Capital market performs well under synergy effect between policy and market demands

Under the synergy effect between policy and market demands, the capital market is confident about developing smart manufacturing industry through investments and developing a healthy innovation ecosystem. From 2010-2014, investment and financing activities in smart manufacturing industry were inactive. Smart manufacturing attracted wide attention of capital market since 2015, with significant increase in the number of transactions and financial scale. From 2016-2018, China’s smart manufacturing industry gained strong growth momentum, approaching the peak of financing activities. In 2018, the total financing scale peaked at USD32.515 billion, accounting for nearly 15% of the total financing scale and 12.22% of the total 942 transactions. We can see that smart manufacturing industry is widely favored by capital.

With high attention on the development of smart manufacturing and industrial robot, the Chinese government has published many favourable policies including the Development Plan for the Robotics Industry (2016-2020), the Three-Year Action Plan for Promoting the Development of AI Industry (2018-2020) and the Smart Manufacturing Development Plan (2016-2020). Then it releases policy instructions to help local governments to develop relevant policies according to their advantages and guide enterprises to actively apply relevant technologies in line with market rules. To respond to policies released by the central government and meet the demands of developing local manufacturing industries, many Chinese provinces and cities announce favourable smart manufacturing policies.

Figure 37: Investment and financing activities in China’s smart manufacturing industry (2015-2018)
Figure 38: Industrial robot policies announced by local governments

Henan, Hebei, Liaoning, Jiangxi & Yunnan
- Support the development of advanced equipment manufacturing industry

Qinghai, Ningxia, Guangxi, Hainan & Anhui
- Promote multi-scenario and multi-domain application of smart manufacturing technologies

Inner Mongolia & Shanxi
- Encourage leading enterprises to develop intelligent products

Jiangsu, Shaanxi & Heilongjiang
- Support leading enterprises to take leading roles in developing industry cluster and smart manufacturing technologies
- Plan to reach a revenue of RMB12-15 billion by 2020 and RMB60 billion by 2025

Hunan, Hubei & Guangdong:
- Advance the industrialization and scaling-up of smart manufacturing
- Plan to reach an output value of RMB100 billion in robotics and related industry in Guangdong by 2020, to reach a revenue of RMB10 billion in industrial robots sales in Hubei by 2020, and to reach RMB20 billion in Hunan by 2020

Beijing
- Research smart manufacturing core technologies and foster smart manufacturing industry clusters
- Promote in-depth application of smart manufacturing technologies and establish innovation application bases
- Plan to reach a revenue of RMB12-15 billion by 2020 and RMB60 billion by 2025

Shanghai
- Increase application scenarios for the deep integration of smart manufacturing with industries
- Plan to reach RMB60-80 billion in robotics industry by 2020

Zhejiang
- Increase application scenarios for the deep integration of smart manufacturing with industries
- Support the development of advanced equipment manufacturing industry and plan to reach an output value of RMB138.2 billion in robot manufacturing by 2020

Chongqing
- Plan to reach an output value of RMB30 billion in intelligent manufacturing by 2020 and RMB40 billion by 2022

Guizhou
- Develop smart manufacturing with big data

Guangxi
- Master intelligent robot component technology

Shenzhen
- Build AI-based manufacturing innovation center to promote technology R&D

Source: Government websites, Deloitte Research
Smart manufacturing company example: Haier Group

Haier Group, established in 1984, is one of the world’s largest home appliance manufacturers. It ranked first among global large home appliance brands in sales for eight consecutive years from 2009 to 2016. It increased global revenues by 10% year on year to RMB266.1 billion in 2018, leading the whole home appliance industry. As a pioneer in the home appliance industry, Haier Group started to construct Internet factories since 2012. Now it has successfully built several Internet factories and developed the first industrial Internet platform COSMOPlat, ushering into the era of smart manufacturing. In 2018, Haier Group was shortlisted in Fortune Global 500. Haier Group’s smart manufacturing innovation activities have two main traits:

1. Develop smart manufacturing ecosystem. Haier Group finds that China’s manufacturing industry has the most complete industrial system although the manufacturing technologies are still inferior to developed countries. Therefore, Haier Group changes the mindset in innovating smart manufacturing by giving up developing special smart manufacturing technologies and products, but focusing on building industrial Internet platform COSMOPlat to establish an inclusive smart manufacturing ecosystem for China’s huge industrial system. COSMOPlat provides advanced technologies and applications centrally for Chinese manufacturing enterprises, customizes solutions for enterprises through cooperation with upstream or downstream enterprises to satisfy individualized demands with high accuracy, and develops a standardized smart manufacturing framework system based on Internet factory model to provide standardized Internet factory models and help enterprises complete the transformation from traditional manufacturing to smart manufacturing.

2. Innovate based on user demands. Haier Group’s Internet factories adopt a user-centric approach, which customizes products based on user demands and realizes flexible production with smart manufacturing technologies in the era of Industry 4.0. On one hand, for the lack of technological innovation and diversified products, Haier Group has to spend a lot in pre-research and production. In order to gain advantages in fierce market competition, Haier embraces smart manufacturing and establishes Internet factories to reduce manufacturing costs and increase profits. On the other hand, Haier Group shifts the main purpose of Internet factories from product manufacturing to service offering and firstly rolls out industrial Internet platform to provide individualized and massively customized solutions and help enterprises to transform and upgrade from traditional manufacturing to smart manufacturing.
Chapter 4 Challenges in the development of China’s innovation ecosystem

1. Core technologies to be further improved

China’s tech innovation ecosystem has achieved high-speed development. Innovative applications are ubiquitous and remarkable achievements have been made in tech, medical, financial and auto industries. Moreover, driven by innovation, education, manufacturing, culture & entertainment and transportation sectors have been optimized and upgraded, driving coordinated development of various industries.

With the increase of scientific research investments and patent volumes, China’s innovation companies and innovative products have gained some competitiveness. Core technology, as one of the most important factors when measuring the innovative development of a country, is closely related with sustainable development of enterprises and their international positions. Chinese enterprises have mastered the core technologies of many industries, such as synchronous satellite system in the communications industry, vaccine R&D in the pharmaceutical industry (including HBVae, EHF-IgM, SARS vaccine etc.) and high precision bearing in the manufacturing industry etc. and achieved remarkable progress. Communications giant Huawei submitted 5,405 international patent applications in 2018, covering innovative research on 5G, array camera, chip R&D etc.
However, in communications, electric equipment and precision instrument and auto manufacturing sectors, especially in terms of semiconductor materials manufacturing, ultra-high precision machine tool production and electronic fuel injection system research, Chinese enterprises are still at the early development stage. They have not yet mastered the core technologies of some industries and heavily rely on external technology assistance. For example, the import of integrated circuit has maintained growth since 2010. In 2018, China’s integrated circuit imports increased by 19.8% to RMB2058.41 billion, with deficit exceeding USD200 billion.

Figure 40: China’s integrated circuit imports (2010-2018)

Chinese high-tech enterprises’ heavy reliance on foreign technologies directly leads to increase in patent fees. Taking the communications industry as an example, Chinese mobile makers have to pay several millions of RMB to Qualcomm every year for using its patents in the 4G era. With the implementation of 5G technology, Qualcomm will receive RMB1 trillion patent fees from China within the coming 5 years.

China lags behind in core technologies for three reasons: capital, talent and policy. Although significant progress has been made in many aspects in recent years, further improvement is still necessary.

In terms of capital, China's overall R&D expenditures increase year by year, but the returns on investment in different industries are uneven, and some industries can't receive enough investments. For example, while pharmaceutical industry holds the second largest patent volumes, it obtains the least investments in eight industries. On one hand, Chinese pharmaceutical enterprises are gaining stronger cutting-edge drug research capabilities, and more and more foreign pharmaceutical enterprises are importing drugs developed by Chinese enterprises with growing transaction size. However, on the other hand, all the 12 most important new drugs selected by the State Food and Drug Administration were developed by foreign enterprises. It is obvious that the investment demand for pharmaceutical research is growing. Improving the returns on investment and injecting limited resources into industries with the largest potential and innovation value have become the major topics.
Talents are important for innovative development of high-tech industries such as AI industry. High-quality talents can support innovative development of enterprises with their skills and experience. Looking at domestic talent supply, domestic university graduates don't obtain enough skills and experience with less access to education resources than universities in developed countries such as the US. However, talents coming from foreign companies or entrepreneurs graduating from foreign universities might face risks such as financing difficulties and fast technology iteration. On the other hand, strategic M&As and talent introduction measures of foreign companies also pose challenges for China to attract more innovation talents.

Top-level design can accelerate and propel innovation in various industries. Government's policy support enables start-ups to focus on research and lay solid development foundation. The government can help build innovation ecosystem via tax incentives, capital support, special projects and favourable talent policies, but how to further improve the execution efficiency and make detailed rules requires serious consideration.

Regarding future development, Chinese manufacturers still have huge opportunities to catch up with foreign peers holding advanced technologies. External political factors force Chinese enterprises to concentrate on independent research and manufacturing. Besides, growing domestic demands will help China achieve greater innovation results. Core technologies are fundamental for the development of innovative industries. If we only focus on a small part of the industrial chain and don't develop independent and controllable core technologies, nothing will be achieved. The most important task for China now is to develop core technologies that can compete with advanced countries under capital, talent and policy support.
2. “False innovation” disrupts innovation environment
In essence, innovation means using original technologies, new production methods and management models to add vitality for the market and industry and increase value. Innovative enterprises need a free competition environment to grow and increase value. If enterprises lacking innovation capabilities and research investments use innovation products without innovation value to compete with other enterprises, this will increase expansion costs and disrupt the innovation ecological environment, leading to the tragedy that genuine innovative ideas will be nipped in the bud. New methods and models contain more uncertainties and risks than existing mature models, but they can bring real growth momentum for industries. Under such circumstance, we should be alert that some enterprises would attract capital in the name of innovation and make unreasonable request. Their practice is contrary to the original purpose of innovation.

In recent years, AI, blockchain and big data have become hot words in the innovation field. The hotter these words are, the more active “false innovation” enterprises will be. Many innovative technologies have been applied in the financial sector. Among these techs, AI is the most widely and most maturely applied. However, some products such as AI-based stock investment apps and wealth management robots just borrow the concept of AI but have never applied innovative AI technologies. It seems that some P2P online lending products adopt innovative models, but actually, they are just fabricating information with rule loopholes, finally damaging the interests of users. Another example is that some companies roll out business expenditure management apps based on intelligent scanning technologies. They boast of their mature AI technologies application, while in fact, they hire human workers to process invoices to read and transcript documents.

High returns on innovation attract some enterprises to obtain the attention and trust of customers and investors via “false innovation” or to monopolize the market by using favorable innovation policies. Such behaviors not only waste public resources, but also inhibit real innovation motivation. For the market and individuals, how to identify real innovation is indeed a science. For the government, how to use policy support to promote justice and equity and prevent false innovation is also an important issue.

The government has increased research expenditures and investments in recent years. Meanwhile, approval procedures should also be stricter and more effective, so as to prevent the intervention of administrative rights and monopoly, avoid resource mismatch, and help government’s investments in innovative industries produce effective results. In this process, policy innovation is becoming more and more important. Facilitating multi-function coordination and establishing anti-monopoly platforms can help create healthy innovation environment and make enterprises gain more innovation motivations. On one hand, patent review agencies should pay more attention to the originality and industrialization possibility of patents. On the other hand, local governments should consider whether applicants have innovation capabilities, whether they can boost the development of local innovative industries and whether they can help local business environment thrive and diversify.
3. Excessively pursuing crash innovation
Innovative companies need to evolve from incubation to maturity, and during this process, capital acts as incubator and driver. However, lured by capital, an increasing number of companies are pursuing crash innovations and financing maximization by attracting investors via concepts for imagination instead of focusing on developing innovative technologies and projects. If an innovative project lacks core competitiveness and focuses only on opportunity and speed, even the strongest capital incubator cannot develop a valuable company.

The activity and prosperity of the venture capital market where companies shorten innovation cycles with an intention to obtain short-term funding is not reflected in real economy. The value bubbles of innovative projects under the irrational exuberance will burst upon a period of value accumulation. Excessive capital hype has adverse effects for companies to build technology and talent bases. In recent years, many companies have only spent three or two years or even 17 months going public from establishment and gained numerous clients in a short time through platform subsidies and income statements with negative net earnings, focusing too much on speed. When finding new business models and potential markets, companies need to take some patience and time in developing them as pushing for a leap straight to innovation brings nothing but harm to the market and companies.

For example, in the sharing economy, a hot area in recent years, bicycle sharing unicorns are suffering from broken capital chains and pledging massive bicycles for borrowings. The root cause is that expanding too fast cannot match with their immature profit models. How to help companies gain profits and prevent from capital losses should be considered before companies’ gaining the next round of funding, but pursuing speedy model innovations distorts priorities of companies and hampers innovative practices.

Innovation should be built on robust basic research to develop valuable products that satisfy market needs through technology-led innovations and ultimately add values to industries. For innovators, funding means both opportunity and risk. What matters most is the transition of role and mindset from followers to pioneers and the utilization of capital. For investors, investing in companies with innovative value and preparing for medium and long-term investment as well as reasonable valuation is the best way to fight against cash crunch and increase return on investment.
4. A wide talent gap

Technological developments and established applications increase demands in communication and instrument manufacturing and development, new retail, finance, new energy and new materials, while there is a shortage of innovative talents, e.g. a lack of over 1.5 million Fintech talents. Besides, regions have no agglomeration advantages with lower talent concentration. Combined with fewer quality talents at home than abroad, the wide talent gap leads to weak innovative strength. Innovative companies are challenged by bringing in and developing talents.

Introducing talents plays an important role in the context of a wide talent gap. All regions are competing for top talents as Shanghai, Shenzhen, Nanjing and Tianjin have introduced policies to bring in overseas talents and attract excellent technicians and developers in entrepreneur services, settlement, and residence visa as well as cash subsidies. The release of talent introduction policies by many regions indicates the vigilance and attention of local governments on talent gaps. Moreover, they need to maintain industry concentration and prevent from resource fragmentation in order to help companies first settle in areas with industrial bases and build a complete closed loop of talent resources from universities and brought in from overseas as well as leading companies and high-tech start-ups with a focus on innovation.

In order to attract numerous quality talents and respond to the growing market, China should place priority on developing educational resources and relevant professionals. It should build strong basic disciplines, actively guide talents to join research and high-level technology workforce, optimize disciplines and launch new majors properly in higher education institutions according to market needs. For example, Chinese universities need to offer more AI related majors against the backdrop of the fast growing AI industry and the increasing percentage across the globe.
In addition to offering relevant majors, universities should provide courses that are highly relevant to practical application in terms of educational contents. Companies and universities can work together in developing quality talents for specific segments and training skilled and experienced technicians. The talent structure adjustment model in Germany is available for reference: as the new mode of production centered on intelligent manufacturing changes the traditional manufacturing, German occupational training schools respond to the trend by adjusting their courses to focus more on information literacy and skill training for students. They adjust the proportions of information technology, engineering and math based on market needs and provide more digital hardware in classrooms to stress the application and improve students’ abilities in knowledge transfer.

Talent is the core of innovative industry development while there is no short cut to expand talent development channels. Developing educational resources in universities with innovative thinking and adjusting the structure of educational industry by learning advanced educational experience are the only way to develop talents who can drive and lead innovations.

5. No quality mind in innovation

Quality is the foundation for innovation and the economic climate is essentially dependent on the growth of quality innovation. Innovation serves real economy rather than capital markets. If companies only pursue seemingly innovative popular concepts and models instead of focusing on improving the quality of innovative products, they just develop imitations without sense of innovation and cannot create highly valuable products.

In the new energy vehicle (NEV) industry, for example, the ownership of electric vehicles in China was 2.11 million in 2018 while over 40 battery fire incidents have happened as of 21 October 2018, raising public doubts about vehicle security. The overall NEV market tends to be active in innovation. As the premise of innovation is product quality and safety, poor-quality innovations may negatively impact on consumer experience. Besides, placing less emphasis on quality will make it harder to scale up and commercialize innovations in relevant sectors and even lower market recognition of the value of products in the context of increasing market attention on reputation and reducing tolerance for safety incidents.

In the manufacturing industry, the trend of automation drives companies to innovate and connect more manufacturing facilities with automatic controlling networks. However, some companies have no network security measures in place while innovating the mode of production, leading to data loss and even large-scale shutdown. Companies’ file loss and terminals losing control caused by ransomware virus in recent years is a typical example. In the internet industry, taken as another example, the first batch of innovators have

![Figure 45: Number of higher education institutions offering AI related majors in the world in 2018](source: www.chyxx.com, Deloitte Research)
gained benefits from the internet and improved the quality of consumption in mobile social networks and e-commerce. Currently, different concepts and terms are springing up, such as social network fission, access to users in less developed areas and privately-owned access to users that gains popularity this year. All of these are in fact variants of internet marketing. Several companies look to gain a little cake from the internet model through such so-called innovations. However, the simple innovation of form will be a flash in the pan if it is not backed by quality technology and design, not to mention making contribution to real economy. Latecomers should focus on internet-based product research and design to innovate and integrate cutting-edge technologies with real economy. Product quality, business model and talent structure create some development space for innovation, among which quality innovation is the most fundamental and favorable aspect to improve customer experience and promote the development of real economy. Providing high-quality products and services is the essential motivation for enterprises to achieve sustainable growth while innovation can help improve the competitiveness and quality of products. Enhancing quality awareness and independent innovation capability of enterprises and actively carrying out quality innovation are very important for preventing economic downturn. Higher quality awareness is the core pillar of innovative development. New products and models need to be supported by secure and achievable applications. A healthy and favorable innovation environment could attract more innovative participants who value quality to provide reliable ground-breaking products for the market.
Chapter 5 New landscape of China's innovation ecosystem

1. The booming digital economy drives the globalization of China's innovation ecosystem

As one of the country's key GDP growth drivers, China's digital economy reached RMB31.3 trillion in 2018 with an increase of 20.9%, accounting for 34.8% of the total GDP. The digital economy is rapidly integrating with the real economy to help the latter, which has reached a bottleneck, get out of the slowdown. In recent years, with the rapid development of internet model and big data, the concept of digitalization has penetrated into various industries and sectors. Driven by digitalization, China's innovative technologies and products are going global.

China's e-commerce, mobile payment and bike sharing, the world-leading innovative models, are closely connected with digital economy. Take online retail as an example, China, the world's biggest online retail market, is taking the leadership in the new digital-driven retail revolution. As estimated by internet retailers, China accounts for approximately RMB9 trillion of the USD2.86 trillion spent by global consumers buying retail goods online in 2018, suggesting that China's online sales are 1.78 times of the global average. E-commerce giant Alibaba provides a platform for global sourcing and its global website has expanded online sales to 190 countries and regions.

Mobile payment is also going global. With over 250 partnerships, Ant Financial is connected with hundreds of thousands of merchants across 54 countries and regions. By providing technical support, Alipay has launched nine localized “Alipays” with local partners along the Belt and Road. In addition, prominent sharing-economy player Mobike has expanded its business to 19 countries, covering more than 200 million users.

Digitalization is essentially a process of sharing. Driven by digital economy, information, resources, platforms and customers are shared by network end users. China's innovation can go global with the support of digital economy, when it is competitive enough. In the future, China can make better use of internet innovation and upgrade to extend to high-end sectors of the industrial chain, cultivate new growth drivers and optimize the economic structure.

Low labor cost is no longer an advantage for China to win competition in the international market. Internet innovation is facilitating the upgrading and development of traditional and emerging industries, as well as labor optimization. Internet innovation will serve as a new driver for traditional industries, as internet connects not only people, but also objects, companies and industries. Internet connection will help traditional industries enhance industrial base and technology innovation capabilities, and promote integration of manufacturing with modern service industry to tap complementary advantages. Internet innovation is also likely to drive "intelligent +" development, saving significant labor cost and enabling transformation of traditional manufacturing.

As one of the countries with the most labor resources, China will see a large proportion of jobs replaced by AI. Such trend will enhance job mobility and drive people to learn new skills and knowledge, therefore promoting labor transformation and upgrading industry to high-end sectors of the industrial chain. Internet innovation stimulates mass entrepreneurship. Upgrading digital economy will bring about closer connection between internet and real economy, releasing more new industry models and markets. Based on internet, shared economy and platform economy will stride forward and trigger further development of mass entrepreneurship and innovation, creating more creative industries and economic development opportunities and delivering high-quality products and services to the world.
2. Regional economic integration further synergizes and allocates innovation resources

Yangtze River Delta, Guangdong-Hong Kong-Macau Region and Beijing-Tianjin-Hebei Region are China’s three major city clusters developing in a synergetic manner. Other economic clusters include the Northeastern Region, central China, middle reaches of Yangtze River, Chengdu-Chongqing Region, Guanzhong Plain and Beibu Gulf economic zone. The synergetic effect of regional economic clusters is significant, as evidenced by nearly 50% of China’s total GDP in 2018 contributed by three major city clusters, which have been playing an important role in driving the country’s economic growth. Based on such advantages, innovation industry leverages integrated and derivative resources and mixed industrial elements, shaping a new landscape of interactive development.

As a good example of regional economic integration in China, Guangdong-Hong Kong-Macau Greater Bay Area has benefited from complementary resources, as each city in the area stands out for its competitive industry (Hong Kong for finance, Shenzhen for hi-tech, Macau for tourism, Dongguan for manufacturing and Guangdong for logistics). It has provided a favorable environment for the integration of technology innovation resources. With booming digital economy, the Greater Bay Area’s advantages have laid a solid foundation for technology innovation. As China’s innovation hub, Shenzhen serves as the technology innovation engine of the area. Over the past 40 years of reform and opening up, Shenzhen has been developed to a city with leading innovation mind-set and strength in China. Five of the country’s top 10 venture capitals are from Shenzhen. The city accounts for nearly one-third of China’s venture capital funds and projects. Shenzhen’s complete industrial chain leads to faster product manufacturing than Silicon Valley. Favorable innovation environment allows Shenzhen to develop to be the undisputed technology innovation center of the Greater Bay Area. As for talents, a large number of top universities across the area have been playing leading roles in technology innovation research. The University of Hong Kong, the Hong Kong University of Science and Technology, Sun Yat-sen University and South China University of Technology in particular, have world-leading technology innovation capabilities and serve as a large platform to attract elites in all fields, proving high-end talents for technology innovation of the Greater Bay Area.

Figure 46: Contribution of each region to China’s total GDP

Source: IMF, National Bureau of Statistics, the World Bank, Deloitte Research
Favorable policies are accelerating the integration of technology innovation resources in each region. Report on the Work of the Government 2018 has proposed to drive innovation along the Yangtze River economic zone and the construction of "central technology innovation zone, technology resource sharing zone, technology-enabled livable zone and technology industry creation zone" in the region. Outline of the Development Plan for the Guangdong-Hong Kong-Macao Greater Bay Area has defined the roles of major cities in innovation and highlighted policies and measures to facilitate cross-boundary flow of innovative elements and regional integration. Measures to drive integrated innovation development across Beijing-Tianjin-Hebei Region, including the establishment of Tianjin Binhai-Zhongguancun Science Park and issuance of Blue Book on the Development of Beijing-Tianjin-Hebei Region, have proved the government's determination to promote regional economic integration.

With the rapid development of regional economy, Guangdong-Hong Kong-Macau Greater Bay Area, metropolitan interlocking region across Yangtze River Delta, Beijing-Tianjin-Hebei ecosystem, Xiamen megalopolis and Changchun megalopolis are emerging fast. Regional economy is likely to shift from regional economic and trade cooperation to collaborative innovation and from co-building production chains to co-building quality life cycles, so as to comprehensively attract and allocate talents, businesses, industries and other innovation resources.

3. Increasingly innovative private companies drive the transformation and upgrading across various industries in China

Private companies have been playing a key role in driving China's economic growth since the reform and opening up. At present, China's private companies have contributed more than 60% of GDP, over 80% of urban job opportunities, as well as over 70% of technological innovations. As China shifts the focus of economic development from rapid growth to high quality, the innovation and upgrading of private companies become critical to the transformation and sound development of China's economy.

Innovation of private companies is an economic imperative supported by the government. At the second session of the 13th National People's Congress, President Xi Jinping joined deliberation with deputies from Fujian Province, and urged solid implementation of the policies and measures to encourage, guide and support the development of the private sector. He also stressed creating favorable conditions for entrepreneurs while driving innovation of private companies.

Private companies used to face many challenges in innovative development. On the one hand, high operational cost has greatly hindered the development of private companies, making it difficult for them to get financing. In terms of business environment, more efforts are needed to foster greater fairness in the market with market-oriented economic system to be further improved. Yet things are getting better nowadays. Firstly, with great policy support including the launch of Science and Technology Innovation Board, it becomes less difficult for private companies to raise fund in an easing financing environment. In addition, private companies are faced with a better business environment, including easier market access, more streamlined approval process, greater legal protection and more slashing taxes and fees. All the above have added momentum to the transformation and upgrading of private companies.

Private companies are driving China's industrial transformation and upgrading through self-dependent innovation. Unlike state-owned enterprises, private companies have their own distinctive characteristics. Highly flexible and market sensitive, private companies are well positioned to accelerate the development of competitive products, drawing on scientific achievements by universities and research institutes. Large-scale application of newly developed high-tech products in the market is required for subsequent update to meet ever-changing client needs. This process is quite demanding on a company's technological capabilities, business proposition, cost, service as well as foresight, and requires years of iteration on a large scale. Therefore, it is necessary for a company to sustain its profitability for continuous and long-term investment in R&D, in order to form a complete loop featuring "develop-go to market-develop". High-tech private companies are generally doing well in this regard.
4. Key mechanism and policy innovation become the driving engine of China’s innovation

According to the Guidelines on Tax Incentives for Mass Entrepreneurship and Innovation issued by the State Taxation Administration in June 2019, China has launched 89 preferential tax measures in succession with respect to vital sectors and key areas of business startup and employment, covering the entire life cycle of an enterprise. The new edition incorporates relevant policies that further help enterprises gather funds, making it easier for micro and small enterprises and individual businesses to get loans from financial institutions. In terms of the entire innovation industry, most preferential policies tend to favor self-dependent innovative companies across various industries including biomedicine, big health, virtual reality, 3D printing, green finance, and new energy power generation through an increasingly diversified manner. The first thing is to further protect intellectual property while increasing the penalties for breaches. Other measures include higher financial subsidies, lower taxes, new management models, talent attraction policies and new platforms and channels, etc.

Innovation is not possible without government and policy support. More favorable institution setup, mechanisms and policies are critical drivers of innovation. Major policies to accelerate China’s innovation include increasing relevant investment and creating a more favorable environment for innovative companies and talent development. Fundamentally, in order to cultivate top innovative talents, it is necessary to increase investment in basic education, strengthen discipline construction, develop a high-quality faculty via various approaches including higher salaries, and inspire creative thinking by establishing research institutes. As for the conversion and application of research results, it is advisable to ensure effective activity management and ease financing environment to boost innovation.

China has officially launched a reform on its science and technology mechanism, with diverse focuses at different stages, including identifying objectives, raising awareness on the importance of science and technology, strengthening the construction of scientific research team, facilitating basic researches, opening up technological market, improving self-dependent innovative capabilities, establishing technological innovation systems through industry-university-research cooperation, and promoting industrialization. By adapting to market dynamics and demands at different stages, mechanism and policy reforms have paved the way for high-quality scientific innovation, thereby adding momentum to innovation. China has initiated a new round of institutional reform by establishing new research institutes to integrate all sorts of resources. The aim is to narrow the gap among science, technology and product, thereby shifting the focus from industry management to function management. At present, China’s increasingly mature science and technology mechanism has become a key driver of China’s innovation, fully
China’s innovation ecosystem continues to expand with support from the capital market especially the launch of Science and Technology Innovation Board

China’s Science and Technology Innovation Board was launched in 2019, with a key focus on companies in high-tech and strategic emerging sectors such as next-generation IT, advanced equipment, new materials, new energy, energy saving and environmental protection, and biomedicine. The new board will provide greater financing support for innovative companies, and strengthen the connection among science and technology, capital and real economy, thereby accelerating the conversion of scientific findings to productivity. Previously, companies which seek listings must get approval from Issuance Examination Committee and meet certain requirements, significantly limiting the development of innovative companies. With a registration-based system, the Science and Technology Innovation Board has adopted more diversified standards, allowing strong tech startups to quickly get listed via Q&As based on information disclosure.

Capital market is a key pillar of China’s innovation. As part of the second-tier market, the Science and Technology Innovation Board signifies greater capital support to China’s innovation ecosystem. In the venture capital market, both the volume and the frequency of investment in innovation have grown year by year, with tech startups in AI, new materials, biomedicine and advanced manufacturing becoming the investment focus. Nowadays, China’s venture capital market mainly relies on domestic channels for fundraising.

In response to the reform towards innovation-powered development, top-level design of the capital market needs to focus on opportunities from scientific and technological innovation. Moving forward, the capital market should further balance its relationship with innovative companies. On the one hand, the capital market should reform and innovate to satisfy evolving corporate and market demands, in order to increase its inclusiveness and adaptability. Meanwhile, it is necessary to highlight the role of capital as the driving force of scientific innovation by adding momentum to market dynamics. In addition, it is necessary to increase transparency of corporate information and improve selection mechanism to avoid pseudo-innovation and overheated capital investment.

In a healthy and sustainable innovation ecosystem, the capital market serves as an accelerator instead of the basis for growth. Only those with strong innovation capabilities and mature models will benefit from the market mechanism. Capital does not guarantee quality technological innovation, though it may help startups expand business scale. Therefore, it is imperative for entrepreneurs to adhere to long-term goals through strategic planning. Doubtlessly, with full support from the capital market, more excellent tech startups and entrepreneurs will emerge and thrive.
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Founded in 2011, Deloitte China Innovation Department is dedicated to providing the clients with "high-value, high-tech and high-touch" services and experience, and promoting Deloitte's innovation development in China by collaborating with 17 innovation departments of Deloitte Global network. By leveraging SPEED SET, a revolutionary acceleration model on Greenhouse platform, Deloitte China Innovation Department senses and engages global cutting-edge and disruptive innovation technologies, connects internal and external resources, facilitates innovation transformation and builds win-win innovation ecosystem by connecting enterprises, government institutions, universities, incubators and innovative technology companies.

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