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# China's Emerging Silicon Valley: How and Why Has Shenzhen Become a Global Innovation Centre

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## CHINA'S EMERGING SILICON VALLEY

How Has Shenzhen Become a Global Innovation Centre



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## Innovation

# China's Emerging Silicon Valley: How and Why Has Shenzhen Become a Global Innovation Centre

BY XIANGMING CHEN AND TAYLOR LYNCH OGAN

**Shenzhen is China's very own Silicon Valley. Find out how it has become innovative by tracing its rapid growth and strategic transition; what are the four of its most innovative companies, and what are the key factors that make it an innovative ecosystem in which companies have thrived.**

Many informed people would have heard about Shenzhen, which has grown, at a break-neck pace, from a small village and China's first special economic zone to a prosperous megacity and an emerging centre of innovation over three decades. Yet how many people, even in the global corporate community, have heard about BYD, which happens to have risen from Shenzhen to the world's manufacturing leader in rechargeable batteries and electric vehicles in 20 years? Probably not many. Besides the tale of Shenzhen as a "miracle city", there is a story to be told about how and why Shenzhen has also become a global hub for innovative companies like BYD. While our previous article in this magazine focused on the rise of BYD with Shenzhen,<sup>1</sup> this article has two purposes. The first is to look at how Shenzhen has become innovative by tracing its rapid growth and strategic transition as a favourable backdrop and then profiling four of its most innovative companies. The second is

to examine the key factors that make Shenzhen an innovative ecosystem in which companies have thrived.

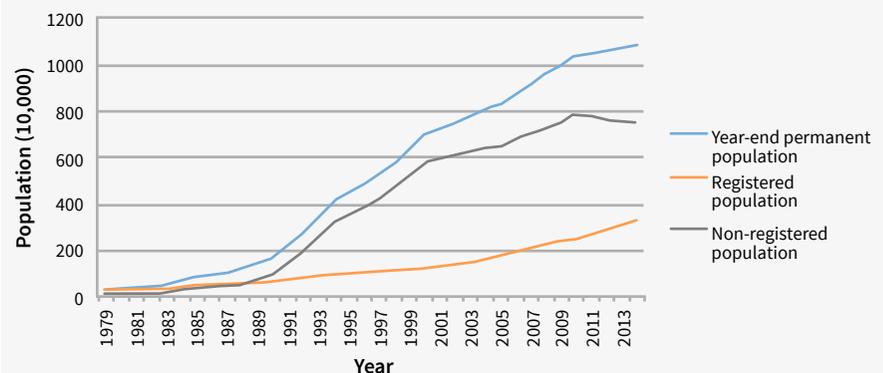
### Rapid Growth and Quality Transition

Few companies can perform well if their home city does not create and sustain healthy demographic and economic growth. This has not been a problem for Shenzhen, which has been one of the fastest growing cities in China and the world for the last 35 years. In fact, no other city anywhere in the world has gained more population than Shenzhen since 1980 (see Figure 1 below). Unlike any other large city in China, Shenzhen has maintained a small proportion of its population (only about 30%) as officially registered with *hukou*. Besides the approximately 70% or eight million long-term residents included in Shenzhen's total population, there are as many as

another eight million short-term residents in Shenzhen today, bringing the total to around 18 million.<sup>2</sup> This qualifies Shenzhen as China's largest immigrant city. The inflow of human resources through the large influx of immigrants has contributed to Shenzhen's innovative capacity (see later).

The rapid growth of Shenzhen's economy has both paralleled and facilitated its structural shift favouring innovation. After averaging about 35% annually for its GDP growth through 1995, Shenzhen kept its annual growth at around 14% through 2014. As a result of this slowed but sustained high growth, Shenzhen's GDP per capita in 2014 reached around \$25,000, the highest of all Chinese cities. At this pace, Shenzhen's GDP per capita is expected to hit \$36,000 in 2020, equaling the 2012 figure for Hong Kong.<sup>3</sup> Driving the more recent and future growth is the accelerated development of services and the relative contraction of manufacturing (see Figure 2 on next page). The still substantial share of GDP in manufacturing is no longer produced by the labour-intensive and low-tech assembling industries that dominated the earlier phase of Shenzhen's economic development. Instead

FIGURE 1. Shenzhen's Population Growth, 1979-2014



Source: Graphed from various Shenzhen Statistical Yearbooks

# In-Depth

**BYD also pioneered a solar tracking system, where the panels can follow the path of the sun across the sky, thus stabilising power generation and matching peak loading time.**

Shenzhen's manufacturing has become increasingly high-tech, new-tech, and clean-tech favouring such industries as new information technology, biotechnology, new energy, new materials, numerical control tools, and robotics. With this shift, the value added of these new industries as a share of GDP rose from 28.8% in 2010, to 35.6% in 2014.

Shenzhen's industrial upgrading has been accompanied and fostered by the continued growth of human capital. As Figure 3 on the next page shows, as the number of college graduates rose, the highly educated base of the population became stronger. In Shenzhen today, college educated talents relative to its permanent population stand at 37.1%, higher than 28.6% in Beijing, and 23.4% in the New Pudong district of Shanghai. Shenzhen's expanded human capital has translated into a greater and more effective capacity of R&D at both the firm and aggregate levels. From 2009 to 2014, the firms' share of Shenzhen's R&D stayed over 90%, and Shenzhen's R&D budget as a share of GDP stood at 4.2%, doubling the national average of 2% and far exceeding the 2.5%, which is regarded as the international norm for innovative economies. High levels of investment in R&D have paid off in the number of patents Shenzhen has applied for and been granted. In 2014, Shenzhen applied for 82,254 patents, up from 42,279 in 2009, and was granted 53,687 patents, up from 25,894 in 2009.<sup>4</sup> Shenzhen-based companies

also accounted for 46.9% of all Patent Cooperation Treaty (PCT) applications from China in 2015. By then Shenzhen led all large Chinese cities in the number of patents applied and grant for 12 years in a row. Through June 2016, Shenzhen accounted for 51.8% of all applied patents in China.<sup>5</sup>

## A Quartet of Innovative Companies

Since firms dominate R&D in Shenzhen, they logically form a wide and deep pool of technological innovation. But do they? What firms lead and in what key industry sectors reflect and represent Shenzhen's growing identity and strength as a global innovation centre? Here we profile four of these firms, all started by entrepreneurs.

### BYD

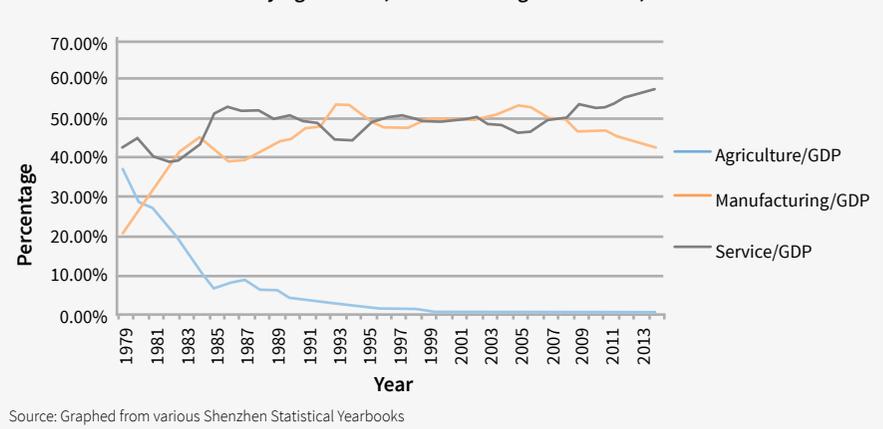
BYD was founded in Shenzhen in 1995 by a young, ambitious battery chemist, Wang Chuangfu, who aptly named his company BYD Co. Ltd., his acronym for "build your dreams". The 29-year-old Wang began making rechargeable batteries for cell phones in his first factory in Shenzhen. Just five years later, BYD was the world's largest cell phone battery manufacturer. The inevitable transition for BYD was to put their battery into a car. Five years

after BYD purchased Xi'an Tsinchuan Auto Co., Ltd., a defunct Chinese automobile manufacturer, in 2003, BYD released the world's first plug-in hybrid electric car, the F3DM. This attracted interest from investors, including Warren Buffett who bought 10% of BYD Co. Ltd. in 2008 for \$230 million, and Wang became China's richest man and has since been one of the wealthiest individuals.

BYD has grown to over 200,000 employees, the largest rechargeable battery manufacturer with over a 25% global market share, and the largest electric vehicle manufacturer in the world. Wang also stresses the other side of the coin, where there must be cleaner alternatives for generating energy, especially now that his company's products demand so much electricity.

BYD soon entered the solar power industry, which Wang stressed was a new energy total solution, one that was not only about grid parity, but also grid quality. BYD's photovoltaic system was multilayered and the first of its kind in the industry, which is now being emulated by companies like Tesla/Solar City. BYD's double-glass solar panel is highly energy efficient, long-lasting, and requires less precious metals in order to be cost competitive. BYD

FIGURE 2. Shenzhen's GDP by Agriculture, Manufacturing and Service, 1979-2014



also pioneered a solar tracking system, where the panels can follow the path of the sun across the sky, thus stabilising power generation and matching peak loading time. Most importantly, the solar tracking system increases the efficiency of the panels by 29%.

BYD also stresses having an inverter in their photovoltaic system, which further increases efficiency and reliability. Arguably the most important part of any photovoltaic system is energy storage, a focus of BYD's from the beginning. The Energy Storage System (ESS) is essentially a big battery that stores the energy produced by the solar panels during the day, which is also the peak loading time for energy usage. By storing the excess energy, the ESS can then feed the grid with its stored energy when demand is high. BYD's newest slogan is aptly "The official sponsor of Mother Nature".

## DJI

Shenzhen is also home to the world's largest consumer drone manufacturer, SZ DJI Technology Co., known to most as DJI. The privately held robotics company's growth is strikingly analogous with that of Shenzhen. Founder and CEO Frank Wang started the company in 2006, and in 2011 DJI was still a startup. Frank Wang's story is cliché Silicon Valley-startup. Growing up, Frank Wang struggled as a student, and at 16 years old, he finally received his long-coveted remote-controlled helicopter, which he reversed engineered. He studied electronic engineering at the Hong Kong University of Science & Technology, and in his senior year he moved with two of his classmates across the border to Shenzhen where he began selling drones to hobbyists out of his three-bedroom apartment.<sup>6</sup>

DJI has been called the "Apple of drones", and Frank Wang "China's Steve Jobs", especially for his unique management practices, even admitting himself to Forbes that he can be an "abrasive perfectionist". When Forbes asked what he thought of being compared to Steve Jobs, he said he appreciates it, his philosophy being, "All you need to do is to be smarter than others."<sup>7</sup> The 35-year-old entrepreneur is now worth over \$3.6 billion, lives in Shenzhen, and drives a four-year-old electric car.

Now DJI has essentially created a market for consumer unmanned aerial vehicles (UAVs) where they currently control over 70% of the global market for consumer drones. DJI is already valued as high as \$10 billion. Their Phantom series of drones, which rolled out in early 2013, finally brought an affordable entry-level drone to the market for \$679. Though they barely broke even on the drone, they priced it so low to essentially create a market for UAVs and to prevent a price war from competitors.<sup>8</sup> DJI's product line extends further than just entry-level drones, however. Their highest level drones are used by nearly every production company in Hollywood, and are even replacing news helicopters.

DJI prides itself on engineering and designing every part of their drones, such as the blades, controller, gimbal, radar sensors, software, and even the camera. It is impressive such a new company is able to manufacture their own camera that shoots 4k video given the complexity of a camera the size of a golf ball. All of their main competitors, except GoPro, an action camera company, outsource at least the camera component of their drones. DJI's gimbal, a mechanism that allows the camera to move on a fixed axis to create a stabilised image, is also incredibly advanced, so much so that DJI even has a product line



DRIVERLESS VEHICLES: BYD joined the crowded field of Google, Tesla, GM, Ford, Mercedes, BMW, etc. in the autonomous-driving industry when they recently partnered with Baidu, known to many as "China's Google" with their new project called the Baidu AutoBrain System. Baidu, whose headquarters is in Beijing, recently moved their International Operations Headquarters to Shenzhen as well as built a new R&D centre where much of the AutoBrain System is created. Dozens of retrofitted BYD cars are being tested with the AutoBrain System throughout Shenzhen. The shift from the engine to artificial intelligence in a car is one that China can actually tackle. Photo courtesy: Qilai Shen/Bloomberg

# In-Depth

for professional camera grips. Their gimbals and cameras have even been spotted mounted to the top of BYD police cars in Shenzhen, likely testing facial recognition software.<sup>9</sup>

## Huawei

Huawei is a leading global information and communications technology (ICT) solutions provider. It overtook Ericsson as the world's largest telecommunications equipment manufacturer in 2012. Huawei was founded in 1987 by Ren Zhengfei, a former engineer in the People's Liberation Army. At the time of its establishment, the company reportedly had only RMB21,000 (\$3,300 in today's US dollar) in registered capital. Its employees, both managers and employees, worked in a small office that also served as a kitchen and dormitory. Huawei focused on manufacturing phone switches, but has since expanded its business to include: building telecommunications networks; providing operational and consulting services, and equipment to enterprises inside and outside of China; and manufacturing communications devices for the consumer market.

During its first few years, Huawei's business model consisted mainly of reselling private branch exchange (PBX) switches imported from Hong Kong. Meanwhile, it was reverse-engineering imported switches and investing heavily in research and development to manufacture its own technologies. By 1990 the company had approximately 500 R&D staff, and began its own independent commercialisation of PBX switches targeting hotels and small enterprises. The company's first major breakthrough came in 1993, when it launched its C&C08 program controlled telephone switch. It was by far the most powerful switch available in China at the time. By initially deploying in small cities and rural areas

and placing emphasis on service and customisability, the company gained market share and made its way into the mainstream market.

Domestic success spurred Huawei to go global. In 1999, Huawei set up its first R&D centre in Bangalore, India. From 1996 to 2000, Huawei made a concerted effort to promote itself at many international expos. It engaged IBM, at a substantial cost, to be its technology-training provider. In 2003, the company entered into a five-year contract with IBM. In 2005, Huawei's international contract orders exceeded its domestic sales for the first time. In late 2010, Huawei was planning to invest around \$500 million to set up a telecom equipment manufacturing facility in Tamil Nadu, India and \$100 million to expand its R&D centre in Bangalore.

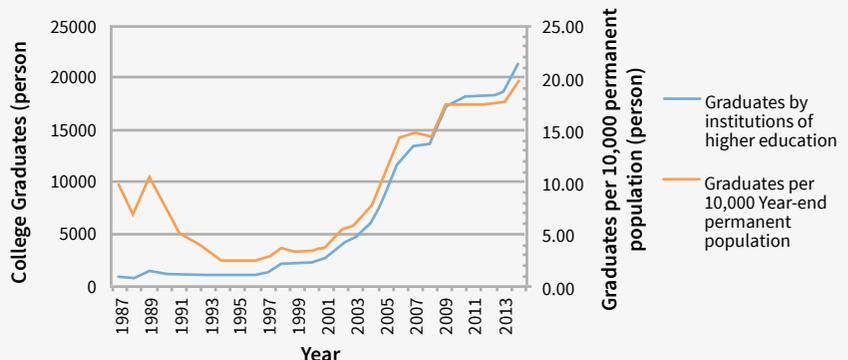
In 2015, Huawei's revenue reached RMB395 billion (\$60.8 billion based on the year-end exchange rate), an increase of 37% year-on-year. Huawei's 4G equipment is widely deployed around the world and is now being used in the capital cities of over 140 countries. Globally, Huawei is setting the pace for IT systems based on cloud architecture. Following a path towards a super-connected world, Huawei is already a leader

in developing 5G, an enabler of disruption. Being one of the newest megacities in the world, Shenzhen is an ideal city to test 5G networks that connect the Internet of Things to smart buildings, devices, appliances, and vehicles. While the technology is still being developed and tested by the world's top telecommunications companies, when released, 5G will connect 100 billion devices, and will be 66 times faster than 4G. 5G is expected to spark the materialisation of wholly new ideas and applications such as virtual reality-based immersive entertainment, remote surgery, and driverless vehicles. Huawei has been conducting much of their 5G testing in Shenzhen, and are likely working with other Shenzhen-based companies, such as BYD.<sup>10</sup>

## Tencent

Tencent is a leading provider of Internet value added services in China and is one of the largest Internet companies in the world. Its many services include social network, web portals, e-commerce, and multiplayer online games. In 1998, Ma Huateng, with four other classmates, co-founded Tencent, after making money playing the stock market. In 1999, inspired by ICQ, the world's first Internet instant messaging service,

FIGURE 3. College Graduates and Graduates per 10,000 Population, 1987-2014



Source: Graphed from various Shenzhen Statistical Yearbooks

developed by an Israeli company, Ma and his team launched a similar software, with a Chinese interface and a slightly different name – OICQ. In December 2000, Ma changed the name of the software to QQ, which became widely popular in China.

In the early 2000s, Ma Huateng expanded Tencent's business portfolio. In 2003, Tencent released its own portal (QQ.com) and made forays into the online gaming market. By 2004, Tencent became the largest Chinese instant messaging service (holding 74% of the market). Later in 2004, Tencent launched an online gaming platform and began selling virtual goods to support the games published on their platform (virtual weapons, gaming power), as well as emoticons and ringtones. In 2005, Tencent launched the C2C platform Paipai.com, a direct competitor to e-commerce giant Alibaba. In January 2011, Tencent released WeChat, a cross-platform instant messaging service, which quickly became one of the largest standalone messaging apps by monthly active users.

Fast forward to June 31, 2016, the monthly active user accounts of QQ

were 899 million while its peak concurrent user accounts reached 247 million. WeChat has over a billion created accounts, 700 million active users, with more than 70 million outside of China. With this huge market, Tencent has passed telecoms giant China Mobile to become the nation's most valuable publicly-traded company. Tencent's new crown as Asia's most valuable company reflects its dominant position, which could pose an eventual challenge to global social networking leader Facebook.<sup>11</sup>

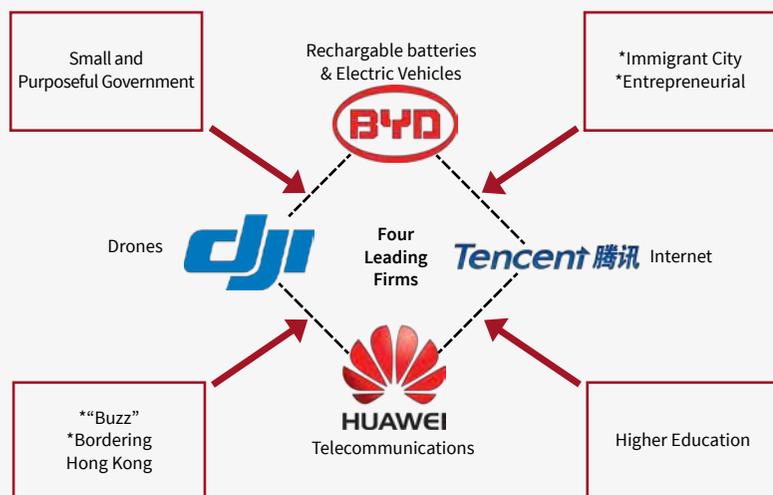
Tencent's newest foray into online payments has also paid off. One of its moves was to invest in Didi Chuxing, a ride-sharing service almost identical to Uber. Didi's seamless integration with WeChat allows WeChat users to order a ride from within the WeChat app, as well as pay or split the fare using WeChat Wallet. This also allows WeChat users to pay for goods and services at numerous shops and eateries, large or small. Very quickly, Tencent has built one of the world's largest payments systems, with transactions that could exceed \$556 billion in 2016, almost doubling the \$280 billion that PayPal banks per year.

## An Ecosystem of Innovation

The four profiled companies exemplify a large number and heavy density of successful firms, mostly privately owned, based in Shenzhen. What explains this clustering in this particular city? We address this question by seeing these companies as embedded and thriving inside a favourable ecosystem, nurtured mainly by four factors (see Figure 4 below). While the four companies represent different industries, they share an underlying emphasis on innovation through strong R&D. BYD relies on its 16,000 R&D engineers and state-of-the-art manufacturing techniques. In 2010, *BusinessWeek* ranked BYD the 8th most innovative company in the world, ahead of Ford, Volkswagen, and BMW. About 40% of DJI staff work in R&D, and they have opened an R&D centre in Palo Alto, California. As of September 2015, Huawei had over 170,000 employees, around 76,000 of whom were in R&D. It has 21 R&D institutes in China, the US, the UK, Germany, Sweden, Columbia, India, and Turkey. More than 50% of Tencent employees are in R&D. In 2007, Tencent invested more than RMB100 million (about \$15 million) in setting up the Tencent Research Institute, China's first Internet research institute, with campuses in Beijing, Shanghai, and Shenzhen.

A small and purposeful local government is the first key to Shenzhen's successful ecosystem for breeding and sustaining innovative companies (the upper left box of Figure 4). This was baked into Shenzhen as a special zone-turned-new city over three decades ago. Untainted with strong state control and economic planning, Shenzhen charted a new course for developing innovative governance and created a municipal government with a more limited structure and purposeful role, not as a comprehensive administrator, but as a catalyst for targeted development

FIGURE 4. Shenzhen's Ecosystem of Innovation



Source: Conceived and drawn by the authors

## In-Depth



Wang Chuanfu, CEO of BYD, with President Xi Jinping and the Duke and Duchess of Cambridge and a BYD Bus in London.

initiatives.<sup>12</sup> In guiding Shenzhen's transition from a low-tech factory town to a global innovation hub, the municipal government has adopted a number of measures to foster creative industries and firms. The local government is spending RMB21.5 billion (\$3 billion) on emerging industries such as new energy represented by BYD. Shenzhen has taken a clustering approach to the cultural and creative industry by creating model bases for creative design, cultural software, animation and games, new media, and so forth. It subsidises up to 70% of rent for "creative" start-ups. The local government also launched the 1<sup>st</sup> Innovation Competition of International Talents held from November, 2015 to April, 2016, which is open to all IT talents around the world, to win a total of \$880,000 bonus plus an additional \$200 million government subsidies and venture capital.<sup>13</sup>

Going beyond citywide policies, the Shenzhen government has targeted specific leading industries and firms. Climate change, energy conservation, and emission reduction has been a high priority. Shenzhen Development

and Reform Commission (SDRC), the most important department under the municipal government and supervised by a Deputy Mayor, oversees urban construction to mitigate climate change and implement clean development policies. Already with the largest fleet of electric vehicles in the world, Shenzhen has recently added 2,000 more – 1,300 buses and 700 taxis – all bought from local EV manufacturer BYD through a subsidy-type program. Major support by a small and purposeful government for a leading firm like BYD illustrates both the relative status of and close interaction between state and market in China, especially in Shenzhen. It is reported that in Chinese cities, government officials walk in front of CEOs of local companies when they meet, while in Shenzhen, CEOs like Wang Chuanfu of BYD walk ahead of government officials.<sup>14</sup> Wang walked side by side with President Xi Jinping of China during the latter's official visit to the UK in October, 2015 when London bought more zero-emission electric busses from BYD (see the photo above).

The second factor in the ecosystem

of innovation is immigration (the upper right box of Figure 4). Shenzhen is the largest city of immigrants in China, especially so if including the temporary migrant population not captured in Figure 1. Interacting with other factors, immigration is an important source of entrepreneurial spirit and drive. Research shows that a high percentage of start-ups in Silicon Valley have been launched by immigrants, largely from China and India.<sup>15</sup> A popular saying in Shenzhen goes, "You are a Shenzheners once you come here." The expression embodies the optimism of the new generation of entrepreneurs, high-tech experts, craftsmen, and others who see Shenzhen as a land of opportunity like no other city in China. "It's a true paradise if you want to create your own business," said James Wang, a 39-year-old Internet entrepreneur in a local science park.<sup>16</sup> The young migrant entrepreneurs today, like their predecessors such as Ren Zhengfei of Huawei and Wang Chuanfu of BYD who migrated to Shenzhen in the 1980s and 1990s, prove that a lesser government and open immigration since the beginning of Shenzhen has maintained an open and attractive environment for some entrepreneurs to succeed.

As China's first special economic zone bordering Hong Kong, Shenzhen has developed a "buzz" that does not exist elsewhere in China (the lower left corner of Figure 4). Besides being linked to economic opportunities, this "buzz" manifests itself in a lifestyle that appeals to young entrepreneurial people. The average age of residents in Shenzhen is 28.7 years old, and people aged 20 to 29 make up 35.8% of the city's population. In comparison, the average age of Shanghai's population is over 40, and people over 60 are 27% of the city's registered population. Around Shenzhen, young people are everywhere and a feeling of

a sense of excitement and dynamism is in the air. This lifestyle for the young was a critical cultural ingredient in the formation of Silicon Valley from its beginning.<sup>17</sup> Half a century later, Shenzhen has reproduced the mutual reinforcement between youth, lifestyle, and immigration in producing an innovative ecosystem.

The demographic and cultural aspects of this system are hardened by the physical location of Shenzhen across the border from Hong Kong. Shenzhen's earlier development and dominance of low-end manufacturing (toys, garments) would not be possible without these factories crossing the border from Hong Kong. Shenzhen's strategic shift to the industries represented by the four firms above has also benefited from the location proximity and relative weakening of Hong Kong. Frank Wang started DJI with his classmates from the Hong Kong University of Science and Technology. In September 2016, DJI opened a flagship store in Hong Kong that will not only serve as a retail outlet, but also provide a prominent space for the worldwide community to share its experience of flight and explore the latest drones and aerial cameras. Given its more developed institution of higher learning and well-established global financial and marketing capabilities, Hong Kong serves as a convenient and suitable neighbour that initiates and sustains fast and dense cross-border flows of human talents, innovative ideas, and business activities.

Hong Kong however has lost luster in innovation as Shenzhen's star has risen. Some companies in Hong Kong have a hard time finding local programmers with both technical skills in coding

and the ability to think independently and creatively. A recent university study reported that there is a widespread feeling in Hong Kong that the city has lost its can-do spirit. A more pessimistic local designer commented, "Innovation wise, Hong Kong is doomed".<sup>18</sup> Is the erosion of Hong Kong's innovation expected or inevitable as the much newer and younger city of Shenzhen across the border has become so innovative? This is not the place to figure out why Hong Kong has become less innovative than Shenzhen. The reversed positions of the two cities on the same border only further highlight Shenzhen's ascent as an innovation centre.

We round up the four corners of the ecosystem (the lower right box of Figure 4) by returning to the rapid growth of higher education as demonstrated in Figure 3. It is no doubt that the presence of top universities such as Stanford in Silicon Valley, MIT in Boston's Route 128, and Duke University in the Research Triangle Park in North Carolina have been critical to the success of these innovation regions. As a "factory city" built off a special zone in its earlier years, Shenzhen was a barren land for higher education. While Shenzhen University was established in 1983, it did not grow to scale and produce more graduates until later. The initial level of college educated were immigrants like Wang Chuanfu of BYD, although the base of college education, in both absolute and relative terms, remained low during Shenzhen's era of traditional manufacturing through the early 2000s (Figure 3). Then higher education took off, spurred by the new graduate schools in Shenzhen established by Tsinghua University

in 2000 and by Peking University in 2001, China's top two universities. This rapid expansion of higher education (Figure 3) has both accompanied and fueled Shenzhen's rise as an innovation centre. It is only fitting that the Shenzhen government is planning to increase the number of colleges and universities to 20 by 2025 when enrolled college students will rise to 250,000, with 200,000 of whom being full-time. If this ambitious plan materialises, Shenzhen will be able to draw a lot more on home-grown human talents to sustain its innovation.

### A Bright Future

If Shenzhen is China's emerging Silicon Valley, is it also on the way to become the world's new Silicon Valley?<sup>19</sup> In one respect, the four companies profiled are global leaders in their respective industries or industry segments. In another, they are already as, if not more, innovative as their best competitors. For example, Huawei submitted 3,442 applications for international patents, compared to 2,409 by Qualcomm, in 2014. The respective figures for Tencent and Microsoft were 1,086 and 1,460. Besides these leading innovators, another telecommunications equipment company based in Shenzhen – ZTE – filed 2,179 patent applications compared to 1,539 by Intel.<sup>20</sup> There is much evidence that Shenzhen has accumulated a critical mass of innovative companies that are beginning to resemble and even rival the original Silicon Valley, at least relative to much of the latter's existence.

Unlike Silicon Valley and most other innovative cities and regions in advanced economies, Shenzhen's rise to an innovation centre has been driven by

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## As Hong Kong has lost some innovative capacity, it has enhanced Shenzhen's already powerful position as a contiguous innovation centre.

a limited and purposeful local government. This distinctive strength has also fostered a faster concentration of innovative technology companies in Shenzhen. Similar to other innovative places, heavy in-migration has created an open and diverse environment conducive to the birth and growth of innovative companies. A buzzing lifestyle has attracted even more entrepreneurial minded young people to Shenzhen. Bordering Hong Kong has facilitated Shenzhen's innovation in two ways. It accelerates and densifies flows of creative ideas and practices. As Hong Kong has lost some innovative capacity, it has enhanced Shenzhen's already powerful position as a contiguous innovation centre. Despite an earlier lack of higher education in Shenzhen, the subsequent rapid expansion has caught up in providing needed human resource for sustaining Shenzhen's innovation. The relative strengths of these four factors have created a favourable ecosystem that distinguishes Shenzhen from other Chinese cities in industrial innovation. This ecosystem also characterises Shenzhen as a new global innovation centre. 

*\*Parts of this article on BYD and other companies were presented by Taylor Ogan at the conference on Asia/Environment, Bard College, Annandale-on-Hudson, New York, 14-15 April, 2016; and at the Center for Urban and Global Studies at Trinity College, Hartford, 20 September, 2016. Helpful comments from these audiences were acknowledged, but we are responsible for any errors in facts and interpretations that might be in this article. We are grateful to the Henry*

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Taylor Lynch Ogan is currently a junior at Trinity College, Connecticut, majoring in Urban Studies. His focus is on the implementation and investment of sustainable energy and electric vehicles, specifically in China. He has done research in Shenzhen, China in the summers of 2015 and 2016 supported by the Henry Luce Foundation, as well as in New York City, Chicago, and Los Angeles.

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- Same as Note 3.

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