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INTERNATIONAL COLLABORATION AND INNOVATION: COMPARING INNOVATION ZONES IN THE CHINESE MARKET

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Cover photograph: The North Campus of Xi'an Jiaotong-Liverpool-University in the Suzhou Industrial Park.

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ABSTRACT

China piloted special economic and technological zones to develop international collaborations and experiment with policy design. This report offers a preliminary overview of three innovation zones in China: Suzhou Industrial Park, Tianjin Eco-city, and Zhongguancun Science Park in Beijing. The research presented incorporates three site visits and interviews with over 60 personnel working for companies, governments, and institutions associated with innovation zones. The report offers insights on how national innovation policies and goals are being put into practice at a local level. It examines the key attributes necessary for the development of an innovation ecosystem within a local area, and reviews the target zones based on these attributes. The attributes examined include human resources, physical resources, capital resources, and government support. The report highlights two innovation partnerships that have emerged between Canada and China, and discusses future research that will contribute to a better understanding of the best ways to foster international innovation partnerships in the Asia-Pacific region. It has implications for both policy-makers and practitioners working with innovation zones.

TABLE OF CONTENTS

INTRODUCTION — 5

BACKGROUND — 7

- THE FOCUS ON R&D AND INNOVATION IN CHINA — 7
- ESTABLISHMENT OF INNOVATION ZONES IN CHINA — 10
- CASE STUDIES OF INTERNATIONAL COLLABORATION INNOVATION ZONES — 11
  - SUZHOU INDUSTRIAL PARK (SIP) — 12
  - TIANJIN ECO-CITY — 16
  - ZHONGGUANCUN SCIENCE PARK (ZGC) — 19

KEY CHARACTERISTICS OF INNOVATION ZONES — 23

- HUMAN RESOURCES — 24
- PHYSICAL AND CAPITAL RESOURCES — 27
- GOVERNMENT — 30

CANADA-CHINA INNOVATION CO-OPERATION — 32

- ZHONGGUANCUN INVESTMENT OFFICES — 32
- UNIVERSITY OF WATERLOO-SOOCHOW UNIVERSITY NANOTECHNOLOGY PARTNERSHIP — 34
  - THE ROLE OF THE SIP — 35
  - THE IMPORTANCE OF STUDENT EXCHANGES — 36
  - ENGLISH AS A COMMON LANGUAGE — 38
  - CHALLENGES AND OPPORTUNITIES — 38

FUTURE RESEARCH OPPORTUNITIES — 40

REFERENCES — 41

INTRODUCTION

In recent years, China moved away from a focus on labour-intensive manufacturing toward a focus on the development of a knowledge-based economy that will allow the country to capture more of the value chain.

A common phrase that captures China's vision is its goal to shift from a "made in China" orientation to a "created in China" orientation. Innovation was cited as a key driver of future economic growth. To foster the shift from basic production to innovation, the Chinese government increased its investments in areas such as science and technology, research and development (R&D), and higher education. The government also sought to tap into the global knowledge base by encouraging foreign firms to transfer both existing technology and R&D operations to China, by building ties with international educational institutions, and by encouraging Chinese students and graduates abroad to return home.

One key component of China's economic strategy was the use of special economic zones to pilot new international collaborations and experiment with policy design. The government followed a similar strategy with regard to innovation and technology, supporting the development of hundreds of new development zones, including economic and technical development zones and high-tech industrial development zones. Many of these zones have reported impressive growth figures, and R&D spending in China has risen rapidly. However, questions have been raised about the effectiveness of some of the Chinese government's policies relate to the technology zones. For example, several of the technology zones are seen as little more than real estate developments by local governments, with subsidies and investments yielding an impressive set of buildings and infrastructure but few real businesses or technological advancements. Firms and zones that receive Chinese government subsidies have little incentive to become truly innovative and able to compete in the global market. Questions remain about whether and how the Chinese government can best foster innovation, and the role that special technology and innovation zones might play.

This paper offers a preliminary overview of research work conducted by the authors in three innovation zones in China – the Suzhou Industrial Park, Tianjin

Tianjin Eco-city

Eco-city, and the Zhongguancun Science Park in Beijing – and is aimed at gaining a better understanding of how national innovation policies and goals are being put into practice at a local level. It also offers some observations about the key attributes necessary for the development of an innovation ecosystem within a local area, and reviews the target zones based on these attributes. Finally, the paper highlights several innovation partnerships that have emerged between Canada and China, and discusses future research that will contribute to a better understanding of the best ways to foster international innovation partnerships.

This research directly responds to the call of the Asia Pacific Foundation of Canada for research on international partnerships and innovation in key Asian markets. APF Canada and the Canadian Council of Chief Executives (CCCE) have identified innovation research as a key focus area, given that Canada's business expenditure on research and development intensity ranked 14th out of 20 economically advanced Organization for Economic Co-operation and Development (OECD) countries in 2006, and Canada's ranking has been essentially unchanged over the past 25 years despite repeated calls and policy initiatives aimed at stimulating much greater R&D effort by Canadian business.[1]

1 Organisation for Economic Co-operation and Development. 1995. OECD Economic surveys: Canada 1995. Paris: Organisation for Economic Co-operation and Development; Canadian Council of Chief Executives. 2006. From bronze to gold: A blueprint for Canadian leadership in a transforming world. Ottawa: Canadian Council of Chief Executives.

BACKGROUND

THE FOCUS ON R&D AND INNOVATION IN CHINA

Following its entry into the World Trade Organization (WTO) in 2001, China intensified its efforts to make its economy and firms globally competitive, striving to improve the technology level and innovation capacity of Chinese firms and industry groups. WTO rules prevented China from requiring foreign firms to transfer technology in exchange for market access, and the opening to global competition required Chinese firms to develop their own technological capabilities in order to compete in the world economy.[2] In 2006, China launched the Medium to Long-term Plan for the Development of Science and Technology (2006-2020), and in October 2010 the State Council of China endorsed a plan to accelerate the development of "strategic emerging enterprises." For national security and commercial reasons, China has prioritized the development of its domestic capacity to foster indigenous innovation.

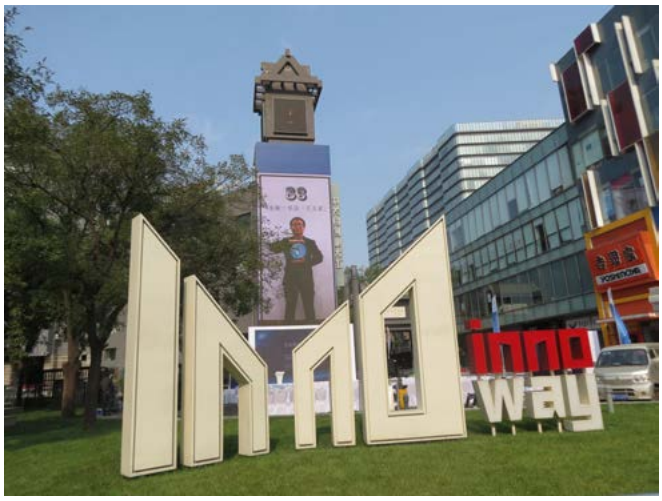
China recognizes, however, that it still lags behind the most developed countries in terms of research capacity in both the institutional and corporate contexts. The country, therefore, has worked to build R&D co-operation with global universities, research institutes, and corporations. China also focused on developing the research capacity of its universities, an area that was traditionally neglected in favour of funding for government research institutes such as the Chinese Academy of Sciences. Governments and universities at the federal, provincial and local levels have worked to attract high-calibre, research-oriented faculty members through special incentives and investments in buildings and equipment to support research work. Programs such as the national Thousand Talents Program have been developed to lure ethnic Chinese students who received PhDs from international universities back to China, offering them competitive salaries, assistance with housing and

2 Springut, M., S. Schlaikjer, and D. Chen. 2011. China's program for science and technology modernization: Implications for American competitiveness. Washington, DC: U.S.-China Economic and Security Review Commission.

cars, schooling for their children, and other perks. Foreign-trained faculty members often return with research projects and research networks developed through schooling, post-doc positions and work in universities, research institutes and companies abroad.

Returning academics have increased the number of joint research projects between Chinese and international universities, helped raise the standard of research, and increased the number of articles and studies published by Chinese scholars in international journals. Their efforts have been supported by the focus on science and technology in Chinese universities. China produces over 900,000 engineering graduates each year, and half of the estimated seven million Chinese university graduates are in engineering, science, and technology fields.[3] During their time in university, many of these science and engineering students work in research labs supporting faculty research projects. The best students go abroad and earn advanced degrees from international universities, and increasing numbers of Chinese students are now returning to China to work for universities, companies, and government institutions.

As will be detailed in the case study of the collaboration between the University of Waterloo and Soochow University profiled in this paper, academic institutions and Chinese academics – especially those trained abroad – play a very important role in the development and success of innovation zones in China. The most famous Chinese technological innovation zone, Zhongguancun, emerged in Beijing due to its proximity to important universities, such as Peking University and Tsinghua University, and national technical research institutes. The Suzhou Industrial Park (SIP), on the other hand, incorporated an education and research component later in its development cycle, using its industrial tax base to finance the construction of research facilities and the Dushu Lake Science and Education Innovation District, which now houses 27 university programs with over 80,000 students and 5,000 faculty members. Academics are also given strong encouragement to engage in commercial activities, with funds and support available to both students and faculty who have a technology or idea that might be commercially valuable. For example, the SIP now houses over 100 business incubators, many of them directly associated with the universities located in the Dushu Lake district.



Entrepreneur Street in Zhongguancun.

The Chinese government has encouraged multinational corporations to increase their R&D spending in China and establish R&D centres in the country, especially within designated technology development zones. Central, provincial, and local governments offer companies perks such as free or reduced rent, tax holidays, and even direct subsidies to locate research operations in specific locations in China. China now houses more than

3 KPMG. August 2013. Innovated in China: New frontier for global R&D. China 360; Kigotho, W. February 28, 2014. China's rapid rise in global science and engineering. University World News.

1,300 international multinational corporation R&D centres, including centres associated with 400 of the Fortune 500 largest global firms.[4] Corporate giants including Microsoft, IBM, General Electric, and Hewlett-Packard have significant research operations in China, and China is the country most often cited by international firms as a future location for R&D centres.[5] Companies have also shifted the focus of their R&D operations in China from an emphasis on market- and cost-driven R&D to knowledge-driven R&D.[6] According to the Chinese Ministry of Commerce, foreign companies increased their share of total R&D expenditures in China from 19.7 percent of the national total in 2002 to 27.2 percent in 2008.[7]

The rise in foreign-led R&D presents both benefits and challenges to China's development efforts. On the one hand, a rise in international R&D and the training that occurs in the R&D centres clearly helps to advance the level of technology and training in the country. The large share of R&D conducted by foreign companies poses challenges, however, because many of the best researchers in China are drawn to these facilities rather than to Chinese domestic research centres, which remain relatively underdeveloped. Most foreign-company R&D is also aimed at adapting or innovating international products for the domestic Chinese market.[8] While some innovations may lead to the development of globally competitive products or new inventions, for the most part the R&D is aimed at assisting foreign companies to compete with domestic Chinese companies in the Chinese market. Therefore, foreign-led R&D in China may hold back some aspects of Chinese domestic R&D efforts in the short run and pose longer-term competitive challenges for Chinese firms.

Chinese domestic R&D efforts have been gaining strength, however. A new set of technologically advanced Chinese companies has emerged in recent years, and these companies are themselves emerging as research powerhouses. The Chinese technology firm Huawei, for example, increased its R&D budget 14-fold from 2004 to 2013 to US$5.5B, and now has approximately 70,000 employees – 45 percent of its workforce – in R&D.[9] The growth of research centres within universities supports stronger collaborations between universities and both domestic and international firms in high-tech fields. Companies find that collaborations with universities pay dividends on several fronts, supporting research efforts, identifying future employees, and building ties to local governments. Local government ties are important because officials often seek advice on technical matters from university experts who have an interest in seeing the growth and development of local educational institutions.[10] Industry partnerships will also pay dividends for universities, providing them with new sources of funds and expertise, and pathways for graduates. Overall, China's research expenditures have grown rapidly and are now the second-highest in the world, behind only the United States. China spent an estimated US$285B on R&D in 2014, a rise of 22 percent from 2012.[11] China's focus on R&D, supported by funding from both the Chinese government and private sources, will support the advancement of technology and innovation in the country in the future.

4 Gassmann, O., and M. Keupp. 2008. The internationalisation of Western firms' R&D in China. International Journal of Entrepreneurship and Small Business. 536–561.

5 Walsh, K. 2007. China R&D: A high-tech field of dreams. Asia Pacific Business Review. 321–335.

6 von Zedtwitz, M., and O. Gassmann. 2002. Market versus technology drive in R&D internationalization: Four different patterns of managing research and development. Research Policy. 31(4): 569–588.

7 Springut, Schlaikjer, and Chen op. cit.

8 Marro, N. June 1, 2015. Foreign company R&D: In China, for China. China Business Review.

9 Siemens. February 2014. Made in China – The next generation. Industry Journal.

10 Marro op. cit.

11 Siemens op. cit.

ESTABLISHMENT OF INNOVATION ZONES IN CHINA

Special economic zones were established by the Chinese government to attract foreign direct investment and advanced technologies and management techniques.

The Chinese government has now established a wide range of economic development zones, including economic and technical development zones (ETDZs) and high-tech industrial development zones (HIDZs). The number of such zones has grown rapidly, and as of 2015 there were 219 ETDZs and 53 HIDZs.[12] Specially designated zones provide the necessary infrastructure and preferential tax and finance support to encourage R&D and innovation activities by companies.[13] For example, high-tech enterprises in ETDZs and HIDZs receive reduced corporate income tax rates of as low as 15 percent, depending on the nature of the enterprise. Special tax credits and exemptions for R&D work and equipment are also available, and firms in these zones that engage in R&D activities are also exempt from paying income tax for the first two years of operations.[14] In addition, high-tech enterprises in technology zones enjoy beneficial loan policies as well as exemptions from restrictive international trade, pricing and personnel policies that apply to firms in other sectors.[15] By establishing innovation zones specialized in advanced technologies, the Chinese government has been able to provide more favourable conditions for the transfer of advanced technology and the development of high-tech business clusters. As a result,

The Dushu Lake Science and Education Innovation District in the Suzhou Industrial Park includes the National University of Singapore's Suzhou Research Institute and several business incubator buildings and spaces.

innovation zones have emerged as a key policy tool to encourage multinational enterprises to transfer high technology and knowledge to China with their foreign direct investments.

A key aspect of China's economic strategy at both the national and local level is its zoned approach to development. The Chinese central government attempts to guide growth by designating which areas of the country are eligible for which types of zones. This national approach to zoning is meant to help develop industry clusters, limit duplication and excess competition between different regions of the country, and encourage growth in western interior or economically less-advantaged areas. Most high-tech clusters are located in eastern China, in relatively advanced areas with high income and education levels that have already seen high levels of investment. The government is encouraging these advanced areas of the country to move up the technology and knowledge chain, allowing more basic manufacturing operations to move to less-advantaged areas where wages are lower and alternative opportunities are fewer.

The zoned approach is also dominant at local levels. Cities, which typically encompass a regional

12 China. National Bureau of Statistics of China. 2015. 2014 annual report of Chinese industry development. Beijing: National Bureau of Statistics of China.
13 Segal, A. 2003. Digital dragon: High-technology enterprises in China. New York: Cornell University Press.
14 World Trade Organization. 2006. World trade report 2006: Exploring the links between subsidies, trade and the WTO. World Trade Organization.
15 Segal op. cit.

area around a central city, have developed elaborate zonal plans that specify the types of economic and social activities allowed within each zone. Each city typically has a heavy industry zone, a light industry zone, a knowledge industry zone, a higher education zone, a tourism zone, a social and cultural zone, and so on. The definitions are often not strict, with a variety of enterprises and activities in each zone. Housing is often scattered throughout the zones, in part because housing development is often the most lucrative form of development for local governments. The dispersed nature of housing causes challenges for the transportation system, as people often must move long distances within a region to reach their workplace and it is difficult to create density to support social and commercial centres. There are also public health and safety concerns, as residential areas may be located next to heavy industrial activities, a situation highlighted in August 2015 when 173 people died due to an explosion at a chemical warehouse in the Tianjin Binhai New Area development zone.[16] Overall, the zoned approach to development is deeply ingrained in China, and will continue to dominate development planning for many years to come.

CASE STUDIES OF INTERNATIONAL COLLABORATION INNOVATION ZONES

While high technology and innovation zones have proliferated in China in recent years, this research project focused on three high-profile innovation zones to gain a deeper appreciation for how China's innovation policy is being implemented at the local level. The three zones chosen are the Suzhou Industrial Park (SIP), Tianjin Eco-city, and Zhongguancun Science Park (ZGC) in Beijing. These zones were chosen as the case study sites because: (1) they represent nationally recognized innovation development zones; (2) the first two represent co-operative international efforts aimed at boosting technology and innovation in China; (3) they are in different regions of China, representing the north (Beijing, Tianjin) and the southern/Yangtze River Delta economic development zone (Suzhou, near Shanghai); and (4) there are significant differences between the three zones in terms of their life cycles and approaches to innovation development.

The researchers made three field visits to Beijing, Tianjin, and Suzhou from March to early September 2015. Policy documents and information were collected from the studied zones and other sources, and interviews with over 60 individuals were conducted by phone and face to face. Additional information was gathered through library and Internet research. This report represents a preliminary discussion of important ideas and information gathered through the research work, but the short time frame limited the researchers' ability to do more rigorous analysis of the interview results.

The research results presented here offer a descriptive overview of each of the three studied zones, highlighting some of the differences between the zones in terms of their origin and development. The research highlights key supportive policies and institutions identified by officials and companies working in the zones. Key conditions for the creation of an effective innovation zone are identified, and the three case study zones are evaluated against these criteria. Two identified areas of co-operation between the studied zones and Canada are highlighted: a partnership between Soochow University and the University of Waterloo in the field of nanotech-

16 The Guardian. September 12, 2015. Tianjin explosion: China sets final death toll at 173, ending search for survivors. The Guardian.

nology, and efforts by ZGC to develop two-way investment partnerships. Finally, recommendations are made for further research and programs that might support the development of innovation co-operation between Canada and China.

Suzhou Industrial Park (SIP)

The SIP developed out of discussions that began in October 1992, when Singapore's Senior Minister Lee Kuan Yew and Deputy Prime Minister Ong Teng Cheong were invited to China by Chinese leader Deng Xiaoping to explore co-operation opportunities. Deng had earlier that year praised Singapore as a model for China in the areas of planned development and economic progress.[17] The two countries decided to develop a new township in China that would be based on Singaporean "software" – techniques of municipal and industrial zone planning and management that had been successful in the development of new townships in Singapore, such as Jurong. These techniques were considered superior to the planning and management techniques employed in China at the time, and were meant as a demonstration zone and specially designated location to attract foreign investors, who were expected to feel more comfortable and confident about investing in an area planned and managed by Singapore.

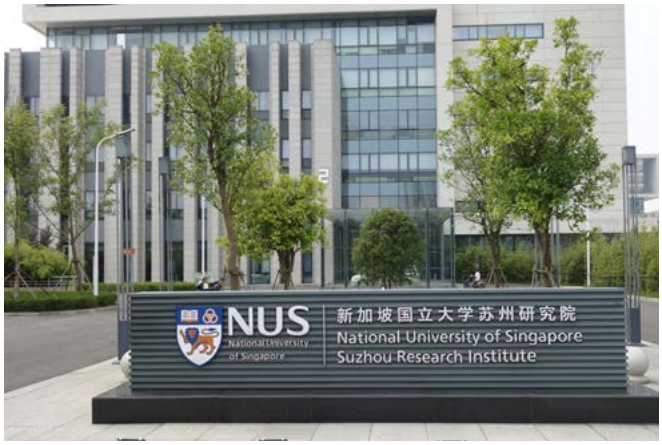
After negotiations, a project was launched in 1994 to create the Singapore-Suzhou Industrial Park (SSIP). It was decided that the Chinese side would provide the land and approvals necessary for the project, and the Singaporean side would provide the development capital and management expertise. The Singaporean side held 65 percent of the shares in the project, and the Chinese side, led by the Suzhou municipal government, held 35 percent.[18] Management and co-operation was structured at three levels: a direct central-government-to-government agreement and commitment at the highest levels of both country governments; a second operational management committee made up of the Suzhou city government and a representative of the Singapore government; and a third level focused on a joint-venture corporation owned by the two governments that was engaged in town planning, property development, marketing, and estate management.[19]

Central government involvement in the project ensured that it received special attention within China, and Singapore's involvement ensured widespread notice in the international community. This was key, as, at the time, the international community retained some skepticism of China's commitment to reform in the wake of the crackdown on government protestors that occurred in June 1989 in Beijing's Tiananmen Square and other areas of China. Politically, the project fulfilled Singapore's desire to develop a

17 Han, M. 2008. The China-Singapore Suzhou Industrial Park: Can the Singapore model of development be exported? Singapore: National University of Singapore.

18 ibid.

19 ibid.



The National University of Singapore's Suzhou Research Institute in the Suzhou Industrial Park.

special link to China, and allowed China to trumpet an international co-operation agreement at a time when it was still under sanction from most western governments.

The project experienced some early success through joint information sharing and the exchange of officials. Government officials from the Suzhou government were sent to Singapore to study how Singapore managed town planning and residential and industrial development. The high-profile project raised awareness of Suzhou, which was a small provincial city located between the much larger cities of Shanghai and Nanjing along the Yangtze River, and numerous delegations of international companies visited the site when looking for locations to open manufacturing operations in China.

The project was less successful, however, in terms of attracting foreign direct investment into the SSIP. The biggest challenge the project faced was competition for foreign investors from other development zones in China – in particular the much larger Suzhou New District (SND), an area of land controlled by the Suzhou government that surrounded the original Singapore-Suzhou Industrial Park. The SND comprised 208 square kilometres of land, an area much larger than the 80-km^2 SSIP. Foreign companies looking for an investment location were steered toward the SND by the Suzhou government because it had 100 percent control over this area and only a minority stake in the SSIP. In 1999, facing rising costs and slow development prospects, Singapore decided to reduce its involvement in the SSIP, allowing the Suzhou government to take over 65 percent of the shares and the overall management of the project. The Suzhou government quickly unified the management of the SSIP and SND, creating the 288-km^2 Suzhou Industrial Park (SIP). The project retains government-to-government status, and Singapore still holds a 35 percent share. Singaporean companies are also deeply engaged as developers and tenants in the zone, but the management of the zone and the surrounding area is now under the control of the Suzhou city government.

After the restructuring, SIP development accelerated. According to the SIP, since its founding, it has achieved an average annual economic growth of 30 percent.[20] The SIP has attracted investments from more than 4,900 foreign invested enterprises (including 88 Fortune 500 companies) that have invested more than US$45B in the zone. It claims to be the highest-ranked development zone in China in the use of foreign capital. More than 18,000 domestic companies have invested in the zone, and it ranks second among national development zones in the national comprehensive development index.[21] The SIP is well connected to the national transportation system, and has its own high-speed rail station that allows access to Shanghai in only 23 minutes. It now houses 1.2 million residents, and its high-quality residential and retail offerings make it the most desirable residential location in the area for both international and domestic residents.

Advanced manufacturing and technology firms are well represented in the SIP. Global firms including Microsoft, IBM, Siemens, Philips, Samsung, Nokia, Honeywell and Fujitsu have operations in the SIP.[22] In recent years, the SIP has worked to move its focus from manufacturing to a stronger R&D, service, and knowledge economy basis, with a focus on biotech, nanotech, and cloud computing. This shift has been characterized as the move from “Industrial Park 1.0”

20 Suzhou Industrial Park Administrative Committee. 2015. China-Singapore Suzhou Industrial Park. Retrieved July 4, 2015, from http://www.sipac.gov.cn
21 ibid.
22 ibid.

to "Industrial Park 2.0."[23] To achieve this goal, the SIP has worked to improve living amenities to provide an attractive environment for knowledge and service workers; developed the Dushu Lake Science and Educational Innovation District within the boundaries of the zone; encouraged lower-end manufacturing facilities to move out of the park to make room for higher-tech firms; and developed specialized areas within the park, including a nanotech zone known as "Nanopolis," a biotech zone, and an international science and technology zone.

The SIP served as a pioneer for a variety of new policies and demonstration zones. It was among the first national eco-industrial and intellectual property rights demonstration zones, and became China's first experimental area on preferential policies for technologically advanced service industries, China's first outsourcing demonstration base, and China's only base for service trade innovation and business tourism.[24] The SIP utilized its connections to Singapore to develop its status as a financial centre, hosting branch offices of 30 domestic and international banks. It was the first development zone in China where firms were allowed to source renminbi (RMB) loans from Singaporean banks, a move that significantly cut borrowing costs. The area has also been a leading experimental area for RMB convertibility, again utilizing the financial expertise of Singapore-based banks and financial institutions to support international trade and operations by firms registered in the SIP.

Nanotechnology, which focuses on the development of new materials, micro-manufacturing

Technology incubators and university facilities in the Suzhou Industrial Park Science and Education Innovation District (SEID).

techniques, and biotechnologies, has been a special area of focus within the SIP. In 2010, the SIP launched "Nanopolis," the world's largest district focused on nanotech research and commercialization. The first phase of the project was completed in 2013, and houses over 100 nanotech companies and more than 20 university and research institutes, including the China-Finland Nano Innovation Center and the Holland High Tech Center (China).[25] All together, US$1B is being invested in the development of Nanopolis, and it is expected to include 1.5 million square metres (16 million square feet) of research, training, and production centres employing more than 10,000 nanotechnology experts when it is completed.[26] In addition to nanotechnology, the SIP has encouraged companies to establish R&D operations, and it now houses over 300 R&D centres employing more than 15,000 researchers.[27] The research centres are generally associated with international companies operating in the zone, including Emerson, Bosch, Samsung, and Panasonic.

A key element of the SIP's program to become a

23 Shanghai, Liu. 2015. National Industrial Park, Zhongguancun obvious advantages ratings. Retrieved October 26, 2015, from http://www.hihuadu.com/2014/12/04/national-industrial-park-zhongguancun-obvious-advantages-rankings-3879.html.
24 ibid.

25 China-Finland Nano Innovation Center. 2015. Suzhou Industrial Park – Your partner to success. Retrieved July 31, 2015, from http://www.nanoinnovationcenter.com/?page_id=277
26 ibid.
27 ibid.

knowledge-intensive zone was its effort to improve the quality and access of higher education within the Suzhou region. In this regard, Suzhou was following the lead of Shenzhen, a special economic zone that focused on technological upgrading through the strategic development of a series of campuses for local, national, and international universities starting in the 1990s.[28] In 2002, the SIP created the Suzhou Dushu Lake Science and Education Innovation District (SEID), a 25-km^2 area within the SIP that now houses campuses or research facilities for 27 universities, including both domestic and international universities. It includes the only international research campus of the National University of Singapore; a branch of Australia's Monash University; a research facility run by the University of California, Los Angeles; and the first Chinese-international university given degree-granting status by the Chinese government, the Xi'an Jiaotong-Liverpool University. More than 2,000 overseas students and 500 foreign faculty members add an international element to the zone. Major Chinese universities with branches in the Dushu Lake SEID include Peking University, Nanjing University, the China University of Science and Technology, and Renmin University of China.

Soochow University, the largest local university, moved its main campus from the central part of Suzhou to the SEID, where it had more room to develop new buildings and expand. More than 80,000 students and 5,000 faculty members now study and teach in the area, creating a vibrant youth culture and source of workers for local institutes and industry. The SIP requires 43,000 new workers each year, and the majority of new graduates from university programs in the SIP stay and work within the Suzhou region. The SIP boasts that it has the highest concentration of college and university graduates of any development zone in China.[29]

28 Chen, K., and M. Kenney. 2007. Universities/research institutes and regional innovation systems: The cases of Beijing and Shenzhen. World Development. 1056–1074.
29 Suzhou Industrial Park Administrative Committee op. cit.

The SIP encouraged both domestic and international universities to locate in the SEID by offering to pay for the construction and upkeep of the buildings and physical infrastructure. This provided an incentive to universities to locate in the SEID, as they were only required to bring their faculty and programs to the newly constructed buildings. While other cities in China offered similar arrangements, the SIP was able to attract a blue-chip list of universities due to its financial resources, the high quality and accessibility of the SIP, and its international orientation built from its longtime collaboration with Singapore. The SIP encouraged highly ranked domestic universities, such as Nanjing University and Renmin University of China, to locate in the SEID in order to build academic prestige and overcome a perception that the local Soochow University was not a top-tier school.

The SIP also focused on foreign educational partnerships when developing the SEID, an idea fostered by the collaboration between Singapore and the SIP. Singapore is a regional academic hub that hosts numerous foreign universities and foreign partnerships. SIP officials were able to visit Singapore and receive training and advice from their counterparts there. In particular, they noted the importance of the use of the English language within the Singaporean education system. In 2012, the Dushu Lake SEID was named a Pilot Area for Higher Education Internationalization by the Chinese Ministry of Education, paving the way for local institutions such as Soochow University to offer programs in English. This designation assisted in the development of innovative partnerships between foreign and local universities. Jiang Weiming, deputy secretary of the SEID, has been quoted as saying, "The Suzhou area is at the vanguard of new ways of thinking about higher education. We are among the first industrial parks going abroad to attract international education institutions. Innovation is the

driving force for the district's rapid development in international education. There has been lots of investment recently into world-leading universities here."[30]

The SEID is one component of an overall talent development program sponsored by the SIP. In 2007, the SIP initiated the Technological Talents Program to ensure that local technology firms had the personnel they needed to support both research and manufacturing operations. In 2010, the SIP initiated the Jingji Lake Double Hundred Talent Program to attract new talented employees with advanced degrees and to offer existing employees opportunities to improve their professional training and explore opportunities to start new companies. Starting in 2011, the SIP committed RMB200M per year (C$40M) to attract highly talented people to relocate to the SIP. The SIP has worked closely with local educational institutions to help them develop their research and teaching capacity, especially in technology fields. For example, the SIP has helped support the development of the Institute of Functional Nano & Soft Materials (FUNSOM) at Soochow University, a world-recognized research facility staffed by internationally trained academics. As is profiled later in this report, FUNSOM has developed an active research and academic partnership with several Canadian universities including the University of Waterloo, Western University and the University of Toronto.

Tianjin Eco-city

Sino-Singapore Tianjin Eco-city is the second collaborative project between the Singapore and Chinese governments. The project was proposed by then Singapore Senior Minister Goh Chok Tong and Chinese Premier Wen Jiabao in April 2007, and began construction soon thereafter.

30 Hu, H., and F. Zhou. March 27, 2015. A frontier of innovative education. China Daily Europe.

The Eco-city site is located on a former wasteland area along the seacoast 45 km from the Tianjin city centre in the Tianjin Binhai New Area, a special economic zone near the Tianjin port. The Eco-city is approximately 10 km from the Tianjin Economic-Technological Development Area, 20 km from the port and 150 km from Beijing. Tianjin Eco-city has a land area of 30 km^2, most of it infill land that was previously salt marshes or industrial sites along the Bohai Gulf. The land in the area is naturally alkaline, limiting its productivity. Through land reclamation, the Eco-city is attempting to create a green oasis in a formerly barren area. In 2012, after several years of land reclamation and infrastructure work, the first apartment buildings were completed and the population grew to 10,000 residents. In 2015, the population is expected to reach approximately 25,000, and after 10 to 15 years of construction it is expected to house its maximum long-range population of 350,000.[31]

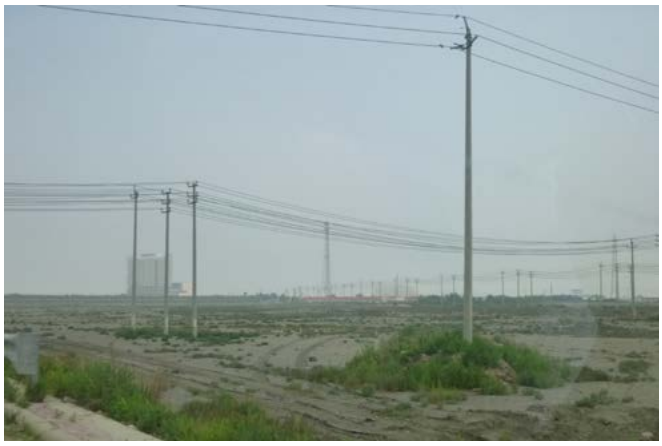
Administratively, Tianjin Eco-city mirrors the structure of the SIP, with three levels of co-operation including a high-level government-to-government agreement and annual meeting; co-operation at the local government level; and a joint-venture arrangement to handle development of infrastructure, housing and office parks and other buildings in the zone. The Singapore partners contributed development capital and knowledge, while the Chinese side provided land and management. The zone is overseen by an administrative committee run by the Tianjin city government. Similar to the SIP, the Eco-city administration was recently unified with the administration of other Tianjin Binhai development zone land near the Eco-city, creating a larger district that includes land for tourism development, light industry, and other uses. This unification was meant to improve planning and avoid

31 Cui, G. 2013. Ecology of the road: In five years SSTEC exploration and practice. In G. Cui. Beijing: Renmin Press.

competition between the areas for companies and investment.

Tianjin Eco-city's vision is to be "a thriving city that is socially harmonious, environmentally-friendly and resource-efficient."[32] The city is being developed jointly by China and Singapore to demonstrate new technologies and planning techniques, and is expected to serve as a model of sustainable development for other cities in China. To meet the goal of sustainable development and resource-efficiency, a comprehensive set of key performance indicators (KPIs) has been established to guide the development of the Eco-city, including 22 quantitative and 4 qualitative KPIs.[33] Examples of KPIs include a goal that all buildings in the zone will be "green" buildings, more than 20 percent of energy will come from renewable sources, over 90 percent of transportation trips will be by mass transit, bike, or walking, and the recycling system will divert more than 60 percent of materials from the landfill.[34] The city seeks to model sustainable development through protection of the natural environment, minimizing impact from the built environment, promoting healthy lifestyle habits, and developing a dynamic and efficient economy. The zone has adopted the China-Singapore Green Building Evaluation Standard to ensure energy efficiency and the use of low-impact materials.[35]

In March 2013, the State Council approved the Eco-city as a national green development pilot area.[36] A series of special finance and investment policies is in place to support both domestic and international companies. In June 2014, the People's Bank of China approved cross-border RMB loans from banks in Singapore to companies registered in the zone, and allowed other cross-border RMB transactions.[37] The Singaporean government also encourages and subsidizes Singaporean companies that invest in the Eco-city. New policies are in development, including policies to support qualified companies from the Eco-city to launch in the Singaporean market, the development of real estate trust investment funds, and support for low-carbon-emission financial pilot sites and financial leasing companies.[38]

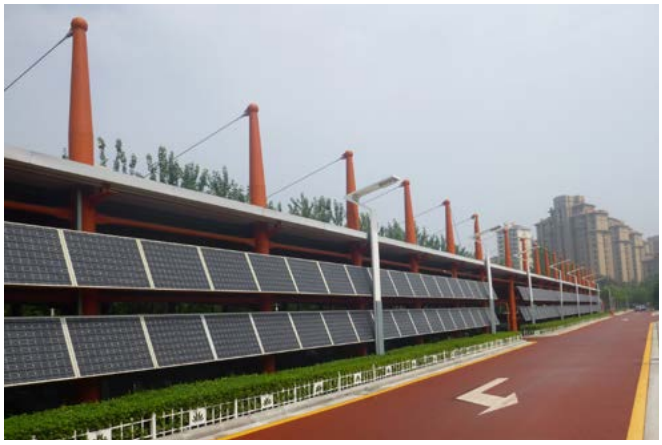


An undeveloped area of the Tianjin Ecocity. Most of the land area of the Ecocity is reclaimed "wasteland" that was previously seashore salt marshes. Only a small part of the Ecocity land area has been developed as of 2015.

The economic development plan for the area calls for restrictions on the types of enterprises that can be located in the Eco-city, with only knowledge industries permitted. Manufacturing is not permitted in the Eco-city, but is allowed in neighbouring areas of the Tianjin Economic-Technological Development Area or Free Trade Zone. The zone is designed around five industrial parks, including the National Animation Park, the National 3D Movie Park, the Eco Science Park, the Eco Industrial Park and the Information

32 ibid.
33 China Academy of Urban Planning and Design, Tianjin Urban Planning and Design Institute, Singapore Urban Redevelopment Authority, et al. 2015. Sino-Singapore Tianjin Eco-city. Retrieved June 10, 2015, from http://www.tianjinecocity.gov.sg/bg_masterplan.htm
34 ibid.
35 ibid.
36 ibid.
37 Cui op. cit.
38 ibid.

Park.[39] Industrial development to date is limited, although several facilities to support animation and 3D movie production have been completed. Output is expected to focus on cultural creation, environmental technology design, green finance, information technology, and green building research and design. The zone is projected to house the knowledge aspects of the value chain, with manufacturing of products such as renewable energy systems or green building products (for example, solar panels) taking place in other areas outside the zone. The zone will consist primarily of office buildings, housing, and social services such as hospitals, retail, and schools.



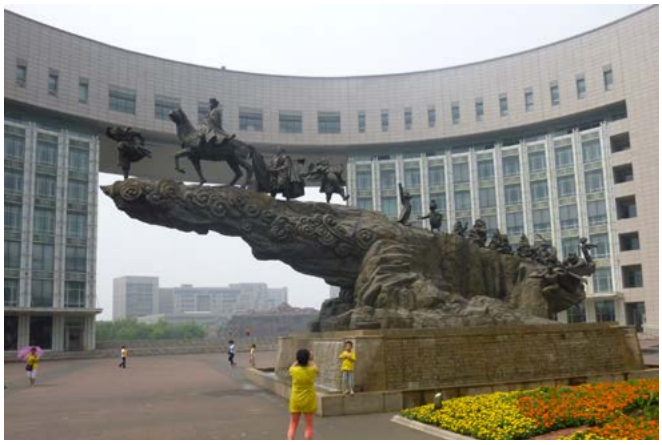
Solar photovoltaic panels along the parking garage of the main administration building at the Tianjin Ecocity.

The largest facility currently developed in the Eco-city is the National Animation Park. The buildings and supporting infrastructure, such as a supercomputer, were developed using funds from the Chinese Ministry of Culture and the Tianjin government. The National Animation Park covers a total area of one km^2 with multiple buildings and advanced facilities. Government subsidies and financial aid are available to attract companies, and the project boasts a large number of registered companies, including the Huaman Brothers, a leading cartoon maker that produces the popular cartoon series Wulongyuan.

Concerns have been raised, however, that many of the companies that register in the Eco-city do not have operations there. For example, in June 2013, a total of 627 enterprises were registered in the National Animation Park; however, there were only around 2,000 people working in the park, including administrative staff and officials.[40] Overall, the Eco-city claims that almost 3,000 companies have registered offices in the zone. Local officials admitted that most companies just register offices in the park to take advantage of special tax and subsidy policies, but maintained actual production centres in other locations. The buildings constructed by the Ministry of Culture, for example, are largely shells where companies retain a registered office but few or no employees. Visits by the authors of this report to the National Animation Park found it almost deserted. Local officials stated that employees and companies are often reluctant to locate in the zone due to the undeveloped nature of the area and the lack of social amenities.

A key challenge in the district is the lack of transportation. Residents must ride a bus for approximately 30 minutes to reach the central commercial section of the Binhai New Area, and over an hour to reach central Tianjin. Ironically, the Eco-city relies heavily on automobile transport given its remote location and the lack of transportation alternatives. The zone boasts wide roadways, and traffic is light given the limited number of residents. Transportation systems are improving, with a light-rail extension bringing the Tianjin transportation system within 15 minutes of the Eco-city by 2016. A new high-speed rail station in the Binhai New Area will help connect the area with Tianjin and Beijing, but the lack of

39 China Academy of Urban Planning and Design, Tianjin Urban Planning and Design Institute, Singapore Urban Redevelopment Authority, et al. op. cit.
40 Cui op. cit.



The main building of the National Animation Park in the Tianjin Ecocity.

population density will slow the development of transportation links between the Eco-city and other areas. Even when transportation links are developed, it is unclear whether the Eco-city will develop as an economically distinct zone or serve primarily as a suburban housing community on the outskirts of the Tianjin-Beijing metropolitan area.

Numerous construction projects are in progress and the number of apartments appears to be growing rapidly. The lead Singaporean company operating in the zone, Keppel, is focused on the development of housing and infrastructure. Basic infrastructure and services are now in place, including a recently opened K-12 international school, a hospital, and a growing number of retail and restaurant choices. The cost of living in the zone is much lower than in surrounding areas such as Tianjin and Beijing. Apartments in the district sell for approximately RMB10,000 per square metre – one-fifth the cost of an apartment in Beijing and much lower than in Tianjin or other more developed areas in the region. Because of the low cost and future promise of growth, many apartments are being bought by real estate speculators rather than residents, holding back population growth. Many of those new buildings in the zone have been observed to have high environmental standards, but remain unused or underutilized. Concerns have been raised that the Eco-city is more of a model than a real city, "A simulacrum of a viable community rather than the real thing."[41]

Zhongguancun Science Park (ZGC)

Zhongguancun Science Park (ZGC), located in the north section of Beijing, is widely recognized as the Silicon Valley of China and home to both established technology companies and many startup firms. ZGC evolved within a supportive ecosystem with over 40 colleges and universities, including globally recognized Peking and Tsinghua universities; more than 200 national scientific institutions, such as the Chinese Academy of Social Sciences and the Chinese Academy of Engineering; and more than 100 national engineering and technological research centres.[42] Beijing has long served as the centre of science and technology development in China. In 2000, science and technology institutions and firms in Beijing utilized 25 percent of total government funding for science and technology research, and 18 percent of all R&D funds in the country.[43]

ZGC hosts over 20,000 high-tech enterprises, and has formed a high-tech industrial cluster featuring electronic information, biomedicine, energy and environmental protection, new materials,

41 Kaiman, J. April 14, 2014. China's 'eco-cities': Empty of hospitals, shopping centres and people. The Guardian. Retrieved June 15, 2015, from http://www.theguardian.com/cities/2014/apr/14/china-tianjin-eco-city-empty-hospitals-people

42 Administrative Committee of Zhongguancun Science Park. 2015b. Zhongguancun Science Park. Retrieved September 30, 2015, from http://wwww.en.zhongguancun.gov.cn

43 Chen and Kenney op. cit.

advanced manufacturing, aerospace engineering, R&D, and service enterprises.[44] ZGC seeks to incubate a group of world-renowned transnational enterprises with strong international competitiveness in the software and information service, biomedicine, and new energy industries. According to the statistics published by ZGC, its total income in 2014 reached RMB2.57T (C$500B), with a year-on-year increase of 19 percent; the gross industrial output value reached RMB690.8B, accounting for over 40 percent of Beijing's overall figure; and the current employed population reached 1.72 million with year-on-year growth of 4.2 percent.[45]

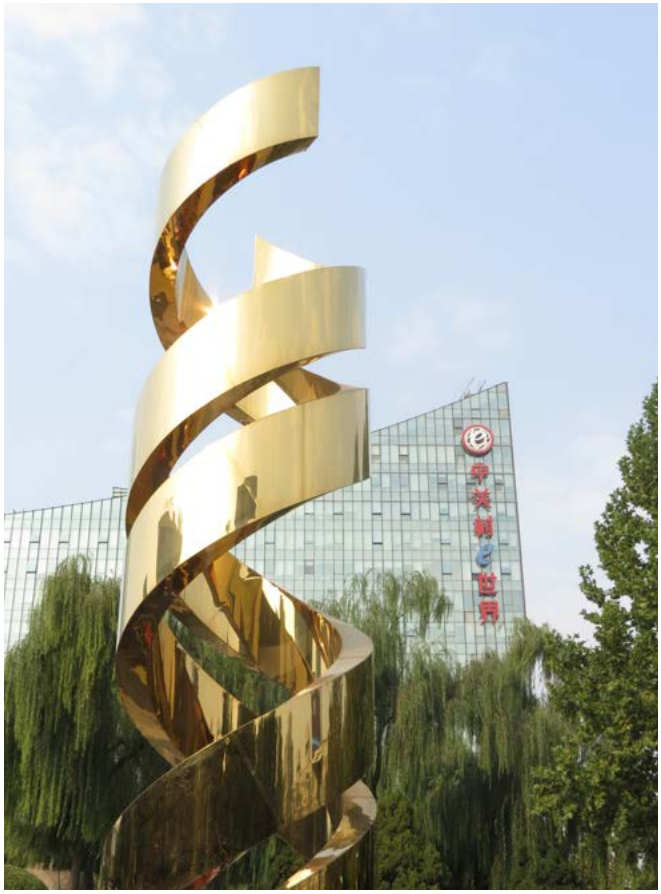
ZGC differs from the other two innovation zones studied in that it emerged from existing institutions and resources, rather than being a deliberately planned government project. The commercialization of technology in ZGC began with the "Zhongguancun Electronics Street" in the early 1980s. Chunxian Chen, a member of the Chinese Academy of Science, came up with the idea of developing the district into China's Silicon Valley after returning from visits to the U.S. in 1980.[46] China's earliest high-tech companies were founded in the 1980s by scientists who worked for universities and research institutes in the area, including Stone Group, Founder Group and Lenovo Group. In 1988, the State Council created the Beijing New Technology Industrial Development Trial Zone to pilot new policies aimed at developing high-tech industries in China.[47] ZGC

3W Cafe in Entrepreneur Street in Zhongguancun, which is widely known as the Silicon Valley of China.

soon emerged from that pilot as the first high-tech park in China, and a 10-year development plan launched in 2011 outlined ambitions for the zone to become an international innovation centre and a leader in the Asia-Pacific region.[48]

In total, ZGC now covers 488 km^2 in the Beijing area, and includes 16 separate parks and zones such as the Zhongguancun Science Town, the Science and Technology Future Town, the Northern Development Belt and the Southern Development Belt.[49] The goal of all the ZGC-affiliated areas is to promote technological innovation and the commercialization of scientific and technology discoveries. The focus of the zone has shifted from nurturing local technology and startups to an emphasis on the role ZGC can play in global innovation networks. International companies have developed global R&D centres in the Zhongguancun Development Group, such as the Microsoft Asia-Pacific R&D Group, whose mission is "Innovation in China, innovation for the world."[50] Scientists and engineers at R&D centres in ZGC

44 Administrative Committee of Zhongguancun Science Park, 2015b, op. cit.
45 Administrative Committee of Zhongguancun Science Park. 2015a. The outline of development plan of Zhongguancun Science Park (2011–2020). Retrieved August 1, 2015, from http://www.zgc.gov.cn/zgcsnghgy/gy/69400.htm
46 Ma, X. 2015. In memory of the founding father of Zhongguancun: Chunxian Chen. Retrieved June 20, 2015, from http://tech.163.com/special/c/chenchunxian.html
47 ibid.
48 Administrative Committee of Zhongguancun Science Park, 2015a, op. cit.
49 ibid.
50 Limin, C. July 28, 2011. Microsoft plans to add R&D staff in Asia-Pacific. China Daily.



Zhongguancun has emerged as a key R&D location.

are working on frontier research topics such as data-intensive computing, artificial intelligence, and next-generation multimedia.

ZGC has emerged as a key R&D location for firms that want to pursue growing opportunities in China and other developing country markets where innovations developed by researchers in Europe or North America may not be applicable. Chinese companies that have emerged from ZGC are also now global leaders, including Lenovo Group, the largest personal computer company in the world. Chinese Internet companies are also based in ZGC, including Baidu (the top search engine company in China) and Sohu (an Internet firm), emphasizing the wide scope of firms. More than 80 companies based in ZGC have listed their shares on overseas stock exchanges, which is one-third of the Chinese companies listed on the Nasdaq stock exchange.[51]

A shortage of qualified talent is often cited as a barrier to science and technological innovation in China. ZGC has worked with the Chinese government to both develop talent in China and recruit talent globally – in particular, Chinese scientists and engineers who received education and/or work experience abroad. ZGC is the most successful innovation zone in China with regard to attracting overseas returnees. Approximately one-third of the talent and scientists involved in the nation's Thousand Talents Program have returned to ZGC, including 80 percent of the program participants in Beijing.[52] Overall, more than 15,000 overseas returnees now work in ZGC, and they have established more than 6,000 enterprises. In addition, ZGC and the government have worked to better engage the local talent base by fostering entrepreneurship and innovation among Chinese university graduates, especially the elite students attending schools such as Peking University and Tsinghua University. The efforts seems to be paying off, as evidenced in a 2013 report that found that 12 percent of Peking University graduates said they have launched a company or were self-employed.[53]

Many graduates from top Chinese universities deem ZGC as the ideal home to realize their entrepreneurial dreams. Robin Li, founder and CEO of Baidu, the largest Chinese Internet search engine and the most popular Chinese website, graduated from Peking University in 1991 and, after completing his master's degree in the U.S., returned to ZGC to launch his entrepreneurial

51 Administrative Committee of Zhongguancun Science Park, 2015a, op. cit.
52 ibid.
53 McKinsey Global Institute. July 2015. The China effect on global innovation. McKinsey & Company.

career. Chaoyang Zhang, the young founder and president of Sohu, another popular Chinese internet company, graduated from Tsinghua University and chose to start his new company close to his former university.[54] Among the top 30 entrepreneurs from China under age 30, 13 have chosen to work in ZGC.[55] A famous "Entrepreneur Street" has developed in the heart of ZGC, lined with cafes such as 3W, Bingo and Cheku, where young entrepreneurs meet to discuss ideas or launch companies. In May 2015, Premier Li Keqiang visited the 3W Café on Entrepreneur Street and told entrepreneurs there, "As China is upgrading its growth mode, your stories of striving for success will inspire an innovation-driven and knowledge-based economy."[56]

Business "incubators" have emerged as a key tool used by governments, companies, and universities to foster entrepreneurism and startup companies. ZGC is home to many famous incubators such as the Innovation Factory, which was founded by Kai-Fu Lee, who served in executive positions at enterprises including Apple, Google, and Microsoft.[57] ZGC also attracts interest from global incubators and venture capital firms. Makers Global, a global incubator headquartered in Silicon Valley in the U.S., opened a centre in ZGC that was aimed at integrating Silicon Valley and Israel with the Chinese market.[58] The centre provides complete incubation and business services to Chinese entrepreneurs, including investment,

Binggo Cafe in Zhongguancun, another famous place for young entrepreneurs to gther and develop ideas.

venture capital, crowd funding, intellectual property, legal services, and road shows.

ZGC has become a centre of venture capital in China. Ten major Chinese private venture capital firms have banded together to form the Zhongguancun Private Equity & Venture Capital Association (ZVCA). The ZVCA provides a variety of services to clients that include startup companies and potential investors, helping to identify and support promising companies both in ZGC and abroad. The ZVCA has approximately RMB100B (C$20B) in assets under management, and is just one example of a venture capital organization operating in ZGC.[59]

54 Zhang, Q., and Y. Xia. 2007. A world top-class Science Park to attract world top-class human resources. XXIV IASP World Conference proceedings, Barcelona.
55 Flannery, R. March 17, 2014. 30 under 30: Rising stars of entrepreneurialism in China. Forbes China.
56 Tiezzi, S. May 8, 2015. Premier Li urges innovation in China's 'Silicon Valley.' Retrieved September 30, 2015, from http://thediplomat.com/2015/05/premier-li-urges-innovation-in-chinas-silicon-valley/
57 Liu, Y. July 21, 2015. Global incubator unveils Zhongguancun center. China Daily.
58 ibid.

59 Zhongguancun Private Equity & Venture Capital Association. 2015. About ZVCA. Retrieved September 30, 2015, from www.zvca.org/enlist-16.html

KEY CHARACTERISTICS OF INNOVATION ZONES

This section of the paper offers a draft framework that outlines important characteristics associated with successful innovation zones. These characteristics are built on the key characteristics described by Michael Porter's "diamond model," with a focus on the "diamond" of factor conditions and the influencing role of government.[60] Factor conditions include human resources, physical resources, knowledge resources, capital resources, and infrastructure.[61] The other three diamonds in Porter's model – demand conditions, supporting industry, and firm rivalry – are less important here because we are looking at how a zone can set the conditions for overall innovation success, rather than analyzing the ability of a particular industry to thrive within a zone. Each zone does have identified focus industries, but it is beyond the scope of this research to examine the industrial structure of those industries to determine if the industry-specific diamond conditions are met. Government is emphasized because, in China, government plays an oversized role with regard to the economy and business, setting regulations, directing planning and development efforts, and investing and participating directly in the ownership and management of companies. In Porter's model, government is outside the diamond structure, but influences each of the diamonds.

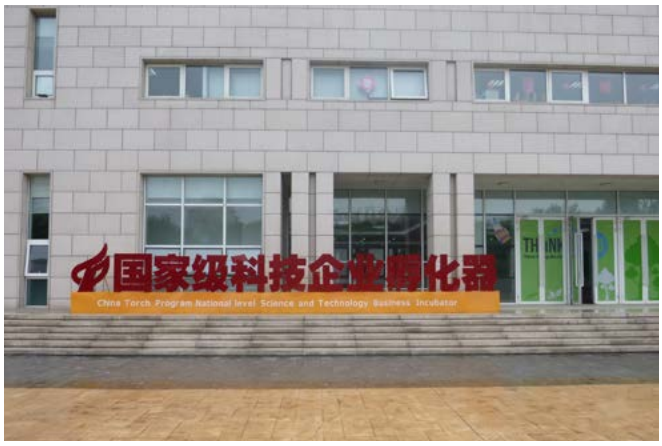
The observations in this section are gained from site visits and interviews of personnel working for companies, governments, and institutions associated with innovation zones, and published information on innovation and innovation zones. This is a preliminary framework meant to help review information gathered on the three innovation zones included in this study. A more formal framework for analysis related to the key factors for success in an innovation zone is expected to emerge through additional research, discussions, and feedback.

The elements of the factor diamond as identified by Porter are simplified here to focus on three areas: human resources (which incorporates

60 Porter, M. 1990. The competitive advantage of nations. New York: The Free Press.
61 ibid.

knowledge resources), physical resources (which includes infrastructure), and capital resources (funding for companies and supporting institutions). Key human resources necessary to support innovation include entrepreneurs with the right set of skills, creativity, and entrepreneurial drive to generate business ideas, and a workforce that can fill positions as companies grow. Physical resources include the land, buildings, advanced machinery, and technology that firms need to scale ideas and bring products and services to market. Infrastructure, including advanced communications and transportation systems, are also important aspects of physical resources. Capital resources include investment capital to assist entrepreneurs as they work to develop and commercialize ideas, and capital support for R&D, education, and other institutions that foster an innovative culture.

Government, especially in China, plays a key role in creating a supportive environment to ensure that firms are able to develop and thrive, and face no insurmountable barriers. Government is the primary source of funding for infrastructure and supporting institutions, such as higher education, and sets the policy environment in terms of regulation and taxation. The factor elements and a supportive environment must generally all be present for commercially successful innovation to occur. An area that lacks an educated and entrepreneurial workforce will not be successful in promoting innovation even if the government adopts supportive policies and funding and physical resources are available (as appears to be the case in Tianjin Eco-city). Likewise, an area with the right workforce but poor policies or a lack of funding or physical resources will also face problems, as entrepreneurs will not be able to get ideas off the ground.



A technology incubator located in the National Animation Park in Tianjin Ecocity.

HUMAN RESOURCES

Arguably, the most important factor for the success of any innovation zone (or economy) is the wealth of human resources available. Knowledge, creativity, innovation, and entrepreneurship are all directly associated with people, and therefore it is crucial for an innovation zone to be a place where people can gain access to the education and training necessary to develop skills, and to be a place where talented people want to live. These factors are accentuated in a knowledge economy in which workers have a choice in where they want to live. Such workers are able to apply their skills in different physical locations, and therefore they often choose their place of residence based on the quality of life available there.

The three zones in this study offer contrasting situations in terms of living environments and educational opportunities. ZGC is located in an established urban area, and was developed due to its close proximity to a large number of top universities and government research institutes. As the national capital and a centre for education and research, Beijing's economy is focused

on knowledge and technology sectors, and it is a cosmopolitan urban area with a large number of international residents and visitors. It has very diverse cultural and social offerings, including restaurants, bars, and pubs with food, drink, and music from around the world. The Beijing area has excellent health facilities and some of the best K-12 education opportunities available in China at university-affiliated, international, and public schools. The explosive success of technology firms in both the hardware field (such as Lenovo) and the software/Internet field (Baidu, Sohu) has given the area the same cachet as that of Silicon Valley, becoming a location that attracts both highly talented entrepreneurs and supporting companies such as venture capitalists.

The primary challenges individuals and companies mentioned about locating in the ZGC area include the high cost of both housing and office space, and a business environment dominated by several very large, established firms, which makes it difficult for small firms to get noticed. Apartments in central Beijing sell for an average of approximately RMB50,000 per square metre (C$10,500), or RMB 4.65M (C$1M) for an apartment (93 m^2 or 1,000 ft^2), with office rents also among the highest in China. Due to the high cost of rent and the lack of available apartments, many people who work in ZGC are forced to live far from the area and endure long commutes. It is also difficult for new graduates or newly established firms to afford to live in the area or rent office space. In addition, the location limits the types of firms that are attracted to ZGC, and excludes most manufacturing operations and companies that need larger factories or workspace.

The SIP includes a mix of urban and suburban environments. It was deliberately established outside a core urban area, and included large plots of land where companies could build offices and factories. Housing included both low-rise and highrise apartments, and the area developed a strong reputation as an attractive place to live. It has an expanding subway network, its own high-speed rail station and a road tunnel to the centre of Suzhou. Apartments sell for RMB10,000 to RMB15,000 per square metre, which is considered a reasonable price and is much lower than prices in central urban areas – Shanghai, in particular. Many people who work outside the SIP live in the zone, including people who commute to Shanghai using the high-speed rail connection. The SIP is the home of a large number of expatriates who work in the foreign companies in the area. A subsidiary manager expressed this idea clearly during an interview: “Many young people and new graduates are attracted to living in this area, although the living cost is much higher than that of other areas in Suzhou. They all know that it is an area where gathers foreign companies, high-tech industries and expatriates, which implies a modern – even a little exotic – lifestyle.”

As described by several interviewed expatriates, they found life in the SIP convenient, diverse, and international. It offers easy access to community recreation centres, parks, retail shopping malls, and western-style pubs, offering a cosmopolitan lifestyle. Although the living cost is comparatively higher than that of other areas in Suzhou, it is still more economical to live in Suzhou than in Shanghai. Many young professionals prefer to work for multinational enterprises in the SIP rather than in larger cities. On the other hand, the comparatively high cost of living in the SIP area leads a large number of workers in the SIP to live in low-cost areas in the city. They have to spend hours daily commuting to work, and voice the need for low-rent housing supported by the local government.

The area includes several lakes, parks, and golf courses, and the local government developed an arts and culture district along the shores of Jingji

Lake that includes a large theatre, and entertainment. Because of the high level of international investment, it has a substantial expatriate population. One of the most important amenities cited by interviewees was the availability of good schools at the K-12 level. The SIP was said to have excellent schools, including international schools associated with Singapore and Canada. The area is fairly affluent, and has attracted high-end retail development including a range of international chains and malls built by South Korean and Taiwanese companies.

The SIP differs from ZGC in that, initially, there were no higher education or research institutions in the area. The creation of the Dushu Lake SEID was a deliberate effort by the SIP to expand educational and research opportunities and develop the type of workforce necessary for knowledge industries. By all accounts the effort has been successful, with a large percentage of graduates from the educational institutions remaining in the SIP or Suzhou region. The SIP has built several rent-subsidized apartment buildings for new graduates who work for companies in the district. The financial strength of the SIP government, which has a large tax base because of the large number of international and domestic companies operating in the zone, allows it to support a number of initiatives such as the talent attraction subsidies that attract high-quality workers to the area.

The challenges faced by the district include its suburban location and the fact that most land in the area has already been developed. The living environment of the SIP is primarily attractive to mid-career, upper-middle-class individuals. While this demographic is important for staffing established companies, it is not a traditional entrepreneurial demographic or hotbed of creativity. To date, none of the new Internet or technology companies in China emerged from the SIP, and it is not a location known for design, music, or

Zhongguancun has a more urban environment.

other creative arts. In contrast to ZGC, which has a more urban, diverse living environment, the competitive advantage of the SIP relates more to manufacturing and materials science, as exemplified by the effort to develop a nanotechnology research and production base. Some respondents mentioned that there was frustration in the SIP government that no large technology companies had developed, but the zone appears to be relatively successful in developing its own niche related to emerging materials and production techniques.

One challenge companies and the zone may face in the future is the rising cost of land, as almost all the land in the SIP has already been developed. The SIP is reportedly forcing companies with low technology or labour-intensive manufacturing to move out of the zone to make room for higher-technology firms and to expand the urban residential and office core of the district. Property prices in the SIP have been rising as redevelopment becomes necessary and it becomes increas-

ingly expensive to buy out existing tenants.

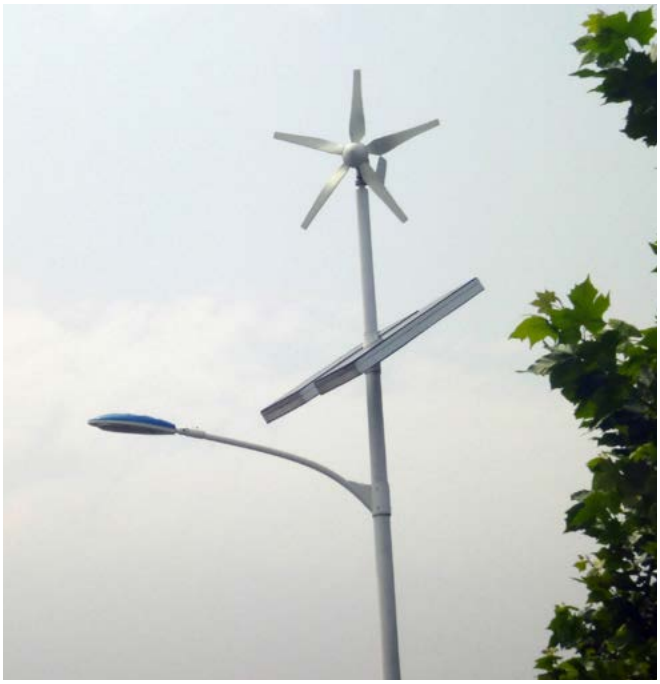
Compared with the SIP, Tianjin Eco-city is at a very early stage of development. To date, the zone has faced challenges in attracting the types of workers and residents that are required to foster innovation. The completion of key amenities, such as the K-12 school, improved transportation, and additional retail offerings, will help encourage professional workers to locate in the zone. Currently, however, the living environment in the Eco-city remains underdeveloped. The populated areas are surrounded by vast tracts of undeveloped wasteland, and urban amenities remain distant and hard to reach. The lack of higher-education institutions and research facilities limits opportunities for R&D, and the overall lack of corporate offices means that there are few professional jobs within the Eco-city.

As well, there are questions about how the Eco-city's focus on environmental sustainability will translate into enhanced innovation. With regard to human resources, the Eco-city is built on the premise that highly talented people will be drawn to live in an area that focuses on sustainability and the environment. However, environmental attributes, such as efficient-energy production, are not directly seen or experienced by residents or workers. Most residents and workers chose a location to live based on more practical concerns, such as the comfort and size of their home or office; the availability of shopping, entertainment, education, and health care; the distance to work; and other factors that directly impact day-to-day living.

The primary environmental aspects of the Eco-city that will encourage individuals and firms to locate in the zone are quality of life issues, such as lower pollution levels and the availability of green space. While the zone put an emphasis on developing parks and green space, it will not be able to control overall air and water pollution levels, which are influenced by industries and residents outside the small zone area. For example, during the researchers' visits to the Eco-city, a perpetual blanket of smog hung over the area. In addition, the August 2015 explosion of a chemical warehouse in the nearby Tianjin Binhai New Area raised questions about whether the whole region is a safe place to live and work given the level of industrialization near the Tianjin port. Many people both inside and outside China now associate Tianjin with lax regulation and dangerous chemicals, a stigma the Eco-city and other nearby areas will need to overcome to become a place where highly mobile knowledge workers will want to live. In sum, while the development progress of the Eco-city has been impressive to date, there are questions about whether the area will be able to attract the types of human resources necessary to become a viable innovation zone.

PHYSICAL AND CAPITAL RESOURCES

The physical and capital resources of a development zone are also important factors with regard to the emergence of innovation within the zone. Compared to many other regions in China, all three of the areas studied in this report are blessed with abundant physical and capital resources. Suzhou, Beijing, and Tianjin are among the wealthiest and most developed areas of the country, with access to high-speed rail lines and major expressways, nearby port facilities, and other world-class infrastructure. ZGC has the advantage of being located in the heart of Beijing, one of the country's largest cities. The SIP and Tianjin Eco-city are both in more suburban areas. The SIP is better integrated with regional transportation systems and is much further along



Streetlamps in the Tianjin Eco-city are wind and solar powered.

the development curve in terms of the availability of housing, warehouse space, and office space.

Together with its Singaporean partners, the Eco-city is working to build a technologically advanced, energy-efficient infrastructure that forms a solid foundation for future development. The more peripheral location of the Eco-city, however, calls into question whether it will be able to successfully integrate key infrastructure such as transportation with a wider regional network. Questions have also been raised about whether the Eco-city actually has better environmental attributes than other cities. A recent study found that in most respects, life in an established regular city such as London has lower environmental impacts than life in the highly engineered Eco-city.[62] The Eco-city may have better environmental performance than other cities in China, but it may not offer lessons that are applicable beyond the country.

The other aspects of physical resources that are important for innovation include access to technology for business applications and research. China's technology level has advanced tremendously since its economic opening in 1978, and in many areas it now leads the world. China has the world's largest high-speed rail network, and it recently won an important contract to build a high- speed rail line in Indonesia over a competing Japanese bid.[63] China lags, however, in many areas related to industrial technology, and Chinese firms have generally been industry followers rather than leaders. Many foreign firms remain concerned about the protection of intellectual property rights (IPR) in China, and are therefore reluctant to transfer their most advanced technology to the country. IPR protections have improved in recent years due to an increased interest among Chinese firms in protecting their own IPR and advances, such as the establishment of new national courts to hear IPR cases.[64] The growth of R&D in China – particularly corporate R&D – also bodes well for future technological advances and continued pressures to improve IPR protections.

The researchers were not able to document significant differences in IPR protections among the three different innovation zones studied; however, the different areas did indicate differing levels of awareness of the issue. ZGC serves as a national IPR Demonstration Park, while Suzhou and Beijing are among the first 23 National IPR Demonstration Cities accredited by the State Intellectual Property Office. These accredited cities have passed all of the evaluations and review

62 Shepard, D. September 22, 2015. China's eco-cities are often neither ecologically friendly, nor functional cities. Reuters.

63 Obe, M. September 29, 2015. Japan says China wins Indonesia high-speed rail contract. Wall Street Journal.

64 Zhai, K. November 2, 2014. China opens intellectual property courts to improve image. Bloomberg News.

criteria, including government support, IPR enforcement, IPR protection, IPR environment, innovative procedures, and performance.

As the national capital and centre for policy formation and implementation, Beijing is at the forefront of IPR policy development in China. It housed the first of the national IPR courts, and officials in ZGC emphasized the importance of IPR protections. Beijing has the largest number of international corporate R&D centres in the country, and is the home of numerous Chinese technology firms. Other leading areas in China with regard to IPR protection include Shanghai and Shenzhen, which also house significant numbers of both domestic and foreign technology firms. In interviews, representatives of the SIP recognized the importance of IPR given the large number of foreign firms located in the zone, and noted that, due to its proximity to Shanghai, firms have access to strengthened IPR protections through the legal system. The Eco-city did not highlight any special IPR measures available to firms, but indicated that no IPR issues or concerns had been reported in the zone.

In addition to infrastructure, capital support of innovation is an important condition necessary to get innovative ideas off the ground. All three areas studied have access to substantial capital resources, both public and private. All three areas receive national government recognition and support. ZGC benefits from its prominence in the capital and the substantial support received from central government funding of institutions such as the national science and engineering research laboratories located in the zone. The core project of Tianjin Eco-city is the Ministry of Culture-funded National Animation Center, while the SIP benefits from its recognition as the national centre for nanotechnology and substantial research support. All three zones are closely aligned with local governments, which fund infrastructure and provide subsidies and support to institutions such as universities that are located in the zones. The SIP and the Eco-city have agreements that allow them to collect and spend tax dollars generated in their areas. This arrangement provides substantial support to the SIP Administrative Committee, given the significant tax base associated with the thousands of companies operating in the zone. While the current benefits are limited in the short term in the Eco-city, the zone may develop deeper pockets over the long term.

One capital source that was highlighted in research visits is the widespread availability of venture capital funds in China, which is connected to a current emphasis on entrepreneurship in the country. These venture capital funds come from both public and private sources, and are further supplemented by the growth in business incubators and enterprise support service centres, many of which are underwritten by local governments. China has a history of government involvement and investment in companies, and many firms in China are state-owned enterprises or Township and Village Enterprises. The current push, however, is more widespread and at a grassroots level. Almost anyone – especially someone with a science or technology degree or experience – is seen as a potential entrepreneur.

China is experiencing an entrepreneurship boom – a phenomenon encouraged by the government, as evidenced by Premier Li Keqiang's visit in early 2015 to ZGC and regular media coverage and encouragement of entrepreneurs.[65] To foster entrepreneurs, local governments and institutions such as universities and research centres have established thousands of business incubators, small business support centres, and venture capital funds in recent years. Entrepreneurs are offered subsidized office space and factory space, location incentives, direct funding, and business support

65 Tiezzi op. cit.

services. In the SIP alone there were reported to be over 100 business incubators, and ZGC contains numerous business incubators and business support programs.

ZGC has the most developed venture capital and business support ecosystem in China. Almost one-third of all venture capital investment in China is made in ZGC.[66] Venture capital funds in ZGC come from both public and private sources. The Beijing municipal government established the Zhongguancun Development Group (ZDG) in 2010 to make equity investments in high-tech companies and to support entrepreneurs. ZDG controls over C$11B in assets and invests mainly in media, Internet, clean technology, biomedicine, new energy, new material, culture, and creative industries. ZDG has established several international offices, including one in Ottawa that is profiled in a case study later in this report.

Private equity investors, including venture capital firms, angel investors, and high-net-worth individuals, are also active in ZGC. The Zhongguancun Private Equity & Venture Capital Association (ZVCA) is a non-profit membership organization co-founded by 10 private equity firms in ZGC.[67] It has over 1,000 associated members, and controls more than C$15B in investment capital. The ZVCA has branched out beyond ZGC to encourage cross-border collaborations among companies and investors. In fall 2015, the ZVCA partnered with both the Canadian and U.S. embassies to organize an innovative tour for Chinese investors and entrepreneurs to visit important tech centres in the U.S. and Canada, including Toronto and Waterloo.[68]

66 Administrative Committee of Zhongguancun Science Park, 2015b, op. cit.
67 Zhongguancun Private Equity & Venture Capital Association op. cit.
68 ibid.

GOVERNMENT

The Chinese government at both the national and local levels is involved with the creation and management of innovation zones, and in the development of supportive policies and infrastructure. In each of the zones studied, the local government plays the largest role in terms of administration of the zones, and also serves as an investor in the zone through government-owned enterprises in real estate and infrastructure development and through equity investments in companies. The Chinese central government has oversight of the policy environment in the zones and is engaged in supporting targeted economic sectors. Local governments are ultimately responsible for implementing tax and other policies, and also provide varying types of subsidies and supports for companies and institutions.

All of the zones studied offer a range of preferential policies to companies, such as reduced tax rates and preferential access to finance and currency exchanges. However, interviews with personnel working in foreign companies in various innovation zones indicated that it is not always easy and accessible for companies to get a complete picture of the policies and supports offered by each innovation zone. Local resources and knowledge are required to gather policy information and negotiate packages of support. Such packages are often negotiated on a case-by-case basis, making it hard to define and understand the full range of policies in place. Local governments also differ in their willingness and ability to reduce regulations or provide guidance and support for potential investors, especially foreign companies, which often have relatively little knowledge of administration procedures in China. In this regard, the SIP was cited by several interviewees as a location that provided special

support to companies, particularly in the area of logistics and customs clearance, helping to cut red tape and guide companies through the time-consuming processes associated with imports and exports.

Overall, governments appear to be playing a largely supportive role in all three innovation zones studied, creating a supportive policy environment, constructing necessary infrastructure, and – in ZGC and the SIP – providing assistance to key supportive institutions in fields such as higher education and research. Governments also played an important role in linking the zones to the global economy and global partners through their work promoting the zones internationally, matchmaking, and assisting foreign firms that locate in the zone. The government taking on multiple roles in the zones, however, creates the potential for conflicts of interest, as governments serve as both regulators and investors within the zone. It is difficult for government to apply policies or regulations evenly when it directly owns some, but not all, firms in the market. The comments from investors about the opaque nature of incentive packages offer hints that not all firms are treated equally in the zones – a condition that may reduce the number of privately owned and foreign companies that want to invest there.

A final concern about the role of government is that government subsidies can often stifle or misdirect innovation compared to a more market-driven system. Companies that rely on government subsidies and preferential policies may have difficulty developing efficiencies and fully adapting to market realities – a charge often levelled at state-owned enterprises in China. This may also be true about startup firms that receive generous support from the government. In addition, government funds might be inefficiently used to build expensive infrastructure to support innovation-related activities. This would appear to be true of some aspects of the current Chinese system of support for entrepreneurs and business incubators. The researchers saw evidence of this in their visits to the three zones, with large government-built facilities such as the National Animation Park and several business incubators standing virtually empty.

Overall, government involvement and support may hold back innovation by misdirecting scarce capital funds into companies and industries that are not supported by the market. It is difficult for government to identify which industries and companies will be successful in the future, and therefore government funds are easily misspent supporting particular favoured industries and companies. The misdirection of capital resources may prevent a more promising sector or company from finding the resources it needs to develop.

CANADA-CHINA INNOVATION CO-OPERATION

This section highlights two important innovation co-operation connections that link Canadian and Chinese organizations associated with the studied innovation zones. The first connection highlighted is the growing level of innovation co-operation between China and Canada through representative offices and venture capital associations connected with ZGC. The second highlighted connection is a faculty and student exchange that began between the University of Waterloo and Soochow University in the field of nanotechnology, and has now grown to include several additional Canadian universities. These case studies were identified through field and academic research, and are meant to highlight exemplary innovation partnerships between Chinese and Canadian organizations. Both emphasize that innovation partnerships flourish when they represent a bilateral arrangement between similar partners.

Many people in Canada assume that innovation partnerships between Canadian and Chinese organizations function primarily by transferring advanced Canadian knowledge to developing Chinese partners. As shown by these two case studies, however, in many respects, the level of technical and scientific knowledge and resources available in China is equal to or higher than the level of knowledge and resources available in Canada. Both partnerships represent true collaborations, and show how important it is for Canada to remain engaged with key partners worldwide if it wants to keep up with global developments and advances.

ZHONGGUANCUN INVESTMENT OFFICES

As part of ZGC's effort to become a global player in technology circles, the Administrative Committee of ZGC and firms affiliated with ZGC have established a network of offices abroad that allow them to connect with individuals and companies in important technology and innovation hubs. Canada plays an important role in

this network of offices, with a variety of Chinese representatives located in key Canadian cities including Ottawa, Toronto, and Vancouver. The brand reputation of ZGC has assisted companies and organizations affiliated with the zone as they seek to build international partnerships and ties. Organizations associated with ZGC have established close relationships with counterparts in Canada, including the government-run Administrative Committee, which oversees the zone, and the Zhongguancun Development Group (ZDG), a state-owned enterprise of investments in high-tech companies.

ZGC's outreach efforts are part of an overall shift that is occurring in China, as Chinese companies and investors look outside China for potential investments and partners. This is known as the "go global" strategy in China, and began with state-owned enterprises looking to expand overseas, such as the 2012 purchase of the Canadian oil company Nexen by the Chinese state-owned enterprise China National Offshore Oil Corporation. In recent years, more and more smaller and private companies from China have looked to make investments overseas.[69] In 2014, China's overseas direct investment exceeded its inward foreign direct investment for the first time, with overseas direct investment reaching C$154B. Overseas direct investment for the first six months of 2015 increased 20.8 percent over the same period in 2014.[70] The capital has been channelled by Chinese investors into more than 6,000 overseas companies in 156 countries.[71]

To encourage international collaboration and innovation, the government-led Administrative Committee of ZGC established five overseas liaison offices in Toronto, Silicon Valley, Maryland, Tokyo, and London. These offices are similar to trade promotion offices organized by Canadian provinces. The offices are funded by the government and help to build awareness of ZGC, and strengthen relationships with overseas Chinese students and scholars, foreign institutions, and high-tech enterprises. The international offices organize regular conferences, events and information sessions to build knowledge of ZGC and to facilitate conversation and collaboration between the Administrative Committee, firms in ZGC, and overseas partners. They help to identify foreign companies and investors that may partner with firms within ZGC, and help to organize informational tours and corporate visits.

The Zhongguancun Development Group (ZDG) is a state-owned enterprise founded by the Beijing municipal government in 2010 to make equity investments in high-tech companies and to support infrastructure in high-tech science parks such as ZGC, including the development of incubators. ZDG has total assets of over C$11B, and plans to invest up to C$1.5B globally over five years to locate promising technology companies worldwide that have the potential to sell into the Chinese market.[72] In 2012, ZDG announced plans to invest C$10M to create a high-tech incubator in Ottawa to help develop Canadian high-tech firms with the potential to sell into the Chinese market.[73] Ottawa was chosen as ZDG's second North American incubator location, in addition to Silicon Valley, due to its thriving technology base and longstanding ties with Beijing, including a sister-city relationship. The partnership blossomed in 2014 when ZDG and Invest Ottawa launched a 1,600-ft^2 incubator facility and announced funding, training, and mentorship support for four Canadian companies, including GREenergy TEC,

69 Fei, Z. March 13, 2015. New challenges for firms going global. China Daily.
70 Nan, Z. September 8, 2015. China's FDI, ODI surge. China Daily.
71 Fei op. cit.
72 Brodie, T. December 11, 2012. $10 million China-backed tech incubator launches in Ottawa. The Globe and Mail.
73 ibid.

iNano Medical, Viscore, and CanShielding.[74] The company screened more than 40 applicants, and selected four companies whose technology was at the ready-to-commercialize stage. ZDG plans to continue to invest in additional Canadian companies in fields such as information and communications technology, life sciences, and clean technology.[75]

Several other joint Canada-China initiatives have also been launched to support entrepreneurship and venture capital opportunities across borders. In September 2015, the Canada China Business Council partnered with Calgary Economic Development to open a new business incubation centre in Calgary. The centre provides a range of professional services to assist Chinese enterprises that are interested in investing in Canada, especially in the oil and gas sector. The centre is expected to build better cross-border understanding of opportunities and business culture, and to help boost economic growth in the region.[76] Vancouver has partnered with the Zhongguancun Private Equity & Venture Capital Association (ZVCA) to hold road shows promoting Vancouver-based companies and business opportunities. The ZVCA also maintains a representative in Vancouver, Jack Chang, who heads Canadian Resources Capital, a private investment firm that seeks to build cross-border investment opportunities and partnerships.[77]

74 Invest Ottawa. April 16, 2014. ZDG International Incubation Centre takes four Ottawa knowledge-based companies to next level of innovation. Retrieved September 15, 2015, from http://investottawa.ca/zdg-international-incubation-centre-takes-four-ottawa-knowledge-based-companies-next-level-innovation/
75 ibid.
76 Toneguzzi, M. September 22, 2015. China business incubation centre launched in Calgary. Calgary Herald.
77 Canadian Resources Capital. 2015. Team. Retrieved September 30, 2015, from http://crcapital.ca/team/

UNIVERSITY OF WATERLOO-SOOCHOW UNIVERSITY NANOTECHNOLOGY PARTNERSHIP

In 2011, the Waterloo Institute for Nanotechnology (WIN) at the University of Waterloo, China's Soochow University Department of Nanotechnology (SUN), and the Suzhou Industrial Park (SIP) partnered to create a Joint Institute of Research and Education with a focus on nanotechnology, a multidisciplinary field that includes applications in areas such as life sciences, material sciences, and energy. Nanotechnology brings together engineering and science to create new materials and techniques that improve the production and operation of a wide range of products, including electronics and health products. China has identified nanotechnology as one of its priority development areas as it seeks to foster innovation and move up the technology scale.

The WIN-SUN-SIP Joint Institute was created based on the strong existing nanotechnology programs and faculty at each university and the focus on nanotechnology in the SIP. The Waterloo Institute for Nanotechnology was founded in 2008, and is recognized as a leader in the nanotechnology field in Canada. Soochow University also began its nanotechnology push in 2008 when it began recruiting overseas Chinese scholars to set up a nanotechnology research centre – an effort that was given a significant boost in 2010 when the SIP, where the Soochow University campus is located, was named the national priority development area for nanotech R&D. Soochow University developed its Institute of Functional Nano & Soft Materials to support research and a College of Nano Science and Technology to support teaching in the field.

According to Alain Francq, managing director of WIN, the nanotechnology collaboration between Waterloo and Soochow developed rapidly because it had the right people in the right places at the right time. In 2010, the Chinese government announced a focus on nanotechnology and began searching the globe for partners to work co-operatively to develop research and applications in the field. Soochow University, through the vision of its president, had already established a research focus in nanotechnology and recruited internationally trained faculty who were familiar with Canadian universities through past studies and research work.

The connection between Waterloo and Soochow was established in 2011 when Soochow invited Dr. Arthur Carty, executive director of WIN, to visit and explore partnership opportunities. Dr. Carty – who previously served as Canada's first national science adviser to the prime minister from 2004 to 2008, and as president of the National Research Council of Canada from 1994 to 2004 – understood the importance of international collaborations if Canada wanted to play a leading role on the global stage in a fast-moving field such as nanotechnology. Dr. Carty played a leading role in the development of the Framework Agreement for Cooperation on Science, Technology and Innovation between Canada and China, signed by the two governments in 2007. Waterloo was looking for international partners with whom it could build research and educational collaborations, and China was a prime candidate due to its growing economic ties with Canada. Soochow was looking for a highly ranked international institution to develop co-operative research and education programs. The invitation from Soochow came at the right time and to the right person who had the interests and networks necessary to develop a strong partnership arrangement.

The role of the SIP

The research partnership between the two universities received a significant boost through the support of the SIP, which helped fund a series of workshops that allowed researchers from Waterloo and Soochow to get to know one another and explore research collaborations, and provided dedicated funding to support research collaborations. Workshops were held in Waterloo and Soochow in 2011, 2012, and 2013, bringing together faculty and students from the two institutions to gain a better understanding of the research work being conducted by faculty at each institution and to explore potential collaborations. Through these workshops, faculty and students got to know each other personally, and were able to see the types of equipment and facilities available for research projects. These meetings demonstrated that the two institutions were on a similar level in terms of the technology available and the types of research being conducted. They also allowed researchers to find complementary areas of research. Because nanotechnology crosses multiple academic fields, successful research partnerships need to be built among researchers in different disciplines and departments. The Joint Institute of Research and Education brought together scholars from various disciplines at the two institutions, fostering creative and complementary research collaborations.

In addition to personal ties, successful institutional partnerships require funding to provide critical resources to support collaboration. The SIP and the Chinese government played a leading role in this regard by making funding available for joint research projects and student exchanges. The SIP created a dedicated research fund and put out a call for proposals for nanotechnology research projects that included Soochow and Waterloo faculty members as co-principal investigators. The SIP contributed RMB9M (C$2M) to support

the joint research projects. Through three rounds of competition, from 2012 to 2014, 19 collaborative projects were chosen for funding. The funds helped support faculty exchanges between the two institutions, with several Waterloo faculty going to Soochow on research leaves or sabbaticals, and Soochow faculty conducting research work at Waterloo. The seed funding from the SIP also laid the groundwork for larger projects and deeper cooperation in the future.

The primary goal of the SIP in providing research funding was to support research work that might yield commercial applications; it had little interest in sponsoring basic research or research that would result in scientific publications but no practical application. As of 2015, one sponsored joint project that involved research to improve micro-electro-mechanical systems for smartphones had reached the commercialization stage, with the SIP working with the Canadian and Chinese principal investigators to develop and carry out a business plan backed by funding from a venture capital fund sponsored by the SIP and other partners and investors. The SIP hopes that this first commercialization project will provide a template for other research projects that have received funding and for future projects.

Both the SIP's commercialization push and its support highlights the interest of the local government in using academia and research as strategies to move the SIP from a focus on basic manufacturing to a focus on higher technology and knowledge-based development and production. The SIP stresses that it intends to move from an SIP 1.0 to an SIP 2.0, mirroring the national shift from "made in China" to "created in China." To support nanotechnology R&D, the SIP created Nanopolis Suzhou, a dedicated area of approximately 40 hectares within the SIP where it plans to support the construction of a mix of advanced research institutions, production facilities, corporate offices, and conference and exhibit spaces focused on the field of nanotechnology. The area has been named the National Nano Hi-tech Industry Base and is said to be the "world's largest hub of nanotech innovation and commercialization"[78].

The importance of student exchanges

In addition to research co-operation and faculty exchanges, a key component of the partnership between Soochow University and Waterloo has involved the exchange of students. Both Jeff Sun and Alain Francq stressed that the growing education exchanges between the two universities, which are now extending to other Canadian universities, are the most important part of their partnership in terms of its long-range sustainability and continued growth. The educational partnerships involve advanced undergraduate and graduate students, and include both credit and non-credit exchanges in both directions. The partnerships have developed over time, with early exchanges being non-credit or short-term research exchanges that helped each institution gain information on the level and capabilities of students from the partner school.

From those early exchanges, the schools have developed more formal programs, and begun to involve more institutions and more creative forms of student exchange. At the undergraduate and master's level, the most important program has been the 3+1+1 program for Soochow students to study at Waterloo. Under this program, top-ranked Soochow nanoscience students spend their final (fourth) undergraduate year as research assistants working with faculty members in labs at Waterloo and completing an undergraduate thesis paper focused on their research work. They

78 Nanotechnology Now. December 13, 2011. Retrieved October 26, 2015, from http://www.nanotech-now.com/columns/?article=603.

remain students of Soochow University, which covers their expenses in Canada. Waterloo allows the students to take one or two academic courses for free during their time at Waterloo. Successful students can then transfer to Waterloo and complete a one-year master's program, usually continuing their work as research assistants for Waterloo professors while completing their degree. This program has proven to be very popular, and due to concerns at Soochow University about the loss of their best students and the costs involved, it is now limited to approximately five students per year. Other undergraduate programs for Soochow students to study at Waterloo include a 2+2 dual-degree program, and short-term non-degree exchanges of three or six months.

A few Waterloo students attend Soochow on one-semester study-abroad programs. Funding to support these programs comes from Soochow University and international scholarships offered by the Chinese central government. The largest group of Waterloo students go to Soochow on co-op programs. All Waterloo students are required to complete several co-op terms during their studies, and a growing number of these students are doing co-op terms as research assistants for faculty members doing nanotechnology research at Soochow University. In 2015, 30 Waterloo students completed a co-op term in Soochow, up from 24 in 2014. These students received a stipend and accommodation from Soochow University, allowing them to gain international experience at little or no personal cost.

A new co-operative PhD program between Soochow, Waterloo, Western, the University of Toronto and the Quebec Institut National de la Recherche Scientifique (INRS) is also playing an important role in developing collaborative research ties across the Pacific. Under this program, PhD students are recruited and admitted to one of the Canadian partner universities. They then complete the first two years of their PhD at their home university, finishing their coursework and beginning research work. The final two years of their degree are spent at Soochow University conducting research. They remain students of their original Canadian university, which in the end grants their degree. Because nanotechnology involves a number of disciplines, the students in the program come from a variety of departments including physics, chemistry, biology, and engineering. Waterloo and Western have been the most active schools in the partnership, with two or three students participating each year, while INRS and the University of Toronto only recently joined the program. Approximately 10 students are expected to participate in 2016.

The program is seen as a win-win for both the Canadian university partner and Soochow, as it allows both universities to overcome specific hurdles. For example, the benefit for Soochow is that it allows it to increase the number of PhD students at the institution and helps build international research collaborations. The Chinese government strictly limits the number of PhD students in each Chinese university. Because the students in this program remain Canadian students, they are not counted against Soochow University's PhD student quota. Meanwhile, the Canadian institutions and Canadian research professors benefit because Soochow University provides some funding support to the Canadian schools, allowing them to admit and fund a larger number of PhD students within their department. After completing their PhD degrees, it is expected that these students will maintain some ties with the scholars and research labs where they worked, both in Canada and in China, widening the collaboration networks further as they build their own careers as teachers and researchers at a variety of international universities and research institutes.

English as a common language

One important factor supporting both research and educational collaborations between Soochow University and its Canadian counterparts is the widespread use of English in the College of Nanoscience and Technology (CNST) in Soochow. Most of the faculty members at CNST were trained in international universities and speak English fluently. The undergraduate students who attend CNST are very highly ranked within China, and often enter with a high standard of English. In their first year, they attend intensive English language courses taught by native English speakers trained to teach scientific English. Almost all courses in years two through four of their program are offered only in English, preparing students for study and research at international schools. Under Chinese regulations, not all Chinese universities are allowed to teach programs in English. However, Soochow University has been named a National Pilot College, giving it more freedom to set its curriculum, teach in English, and build international partnerships. The growing use of English in Chinese universities, supported by Chinese government policies that encourage overseas Chinese scholars to return to China to teach and take up research positions, will help facilitate an increase in student and faculty collaborations at a wider range of Chinese universities in the future.

Challenges and opportunities

Despite its growth and success to date, the Soochow-Waterloo partnership faces some long-range sustainability challenges. Successful partnerships depend on the continuing interest and support of both higher-level administrative personnel and those carrying out the joint projects. There are questions as to whether the future administrators or deans will continue to support the collaborative arrangements with funding, recognition, and work time, and whether faculty will be willing to commit the extra time and effort to build and maintain research collaborations that stretch around the globe. Faculty efforts to build and maintain research collaborations need to be recognized within institutional systems in terms of promotion and funding support. This has occurred so far, but it will be important for future administrators to maintain an international outlook and continue to support international collaborations.

The heavy reliance on funding from various sources in China, including the Chinese central government, the Jiangsu provincial government, the SIP, and Soochow University, to support the ongoing educational co-operation between Soochow and Waterloo and other Canadian universities also creates some risk for the program. To date, Canadian funding to support the project and research collaborations has been limited. In 2011, the Canadian government did announce a five-year C$5M commitment to funding for co-operative projects between Canadian and Chinese institutions and companies for joint research and development projects under the International Science and Technology Partnerships Program and the Framework Agreement for Cooperation on Science, Technology and Innovation between Canada and China. However, overall Canadian funding for science research, education, and international exchanges has been falling, and no new funding initiatives have been announced. Almost all of the funding to support research and exchanges under the Soochow-Waterloo partnership have come from the Chinese side. The current economic cooling in China, and the slowing real estate market in the country, threaten to undermine the funds available to local governments such as the SIP.

However, despite a cooling economy – and perhaps emphasized by it – the Chinese government at all levels has shown a strong commitment to

education and innovation, seeing the two as playing a mutually supportive and central role in the transformation and future development of the Chinese economy. The central Chinese government has worked with local governments and educational institutions to support programs such as the Thousand Talents Program, which aims to recruit talented academics from around the world to work in China and help raise the level of education and research in the country. Governments at all levels have also greatly increased their support for innovation and commercialization of knowledge. They have established thousands of "incubators" that offer startup firms office and factory space, venture capital funds, and administrative support. The nanotechnology push in the SIP is primarily driven by commercial development goals, and academics and students trained abroad are seen as prime candidates with the knowledge, networks, and ideas necessary to create successful nanotechnology enterprises. Therefore, it is unlikely that the Chinese government will cut funding to these projects in the near term, seeing them as crucial to the future development and continued transformation of the Chinese economy.

Jeff Sun of Soochow University and Alain Francq of the University of Waterloo both highlighted continued and expanded student involvement in the co-operative programs as the key to the future sustainability and long-range success of the collaboration. A steady flow of students in both directions will build a widening network of individuals with knowledge of the partner institutions and countries. Many of the Chinese students who come to Canada for undergraduate studies will stay for masters or PhD studies and build connections both with the country and with specific researchers and research projects. Canadian co-op and PhD students who work in China gain a much deeper appreciation for the significant advances China has made in terms of its scientific and technical level, and build a broader understanding of China and ties to individual Chinese scholars. Over the long term, the knowledge and connections developed by students participating in educational exchanges will build truly collaborative and dynamic research and innovation ties between China and Canada.

FUTURE RESEARCH OPPORTUNITIES

This paper provides an overview of three innovation zones in China, and examines the innovation policies and programs being put into practice at a local level. By examining and comparing several key attributes of successful innovation zones, the paper offers a preliminary framework evaluating innovation zones, including a discussion of key factors such as human resources, physical resources, capital resources, and the role of government. The research informs policy-makers at both local and national levels of forming policies and regulations encouraging innovation and sustainable development. It helps global business firms and investors better understand the role of innovation zones and how they are related to innovation initiatives and practices.

Several areas of future research emerge from the current study. For example, it would be helpful to develop a more comprehensive framework for analyzing the key factors and prerequisites of successful innovation zones. Additional research into key factors that support innovation would allow the creation of a stronger theoretical framework for understanding the role that innovation zones in China might play in fostering the development of a knowledge economy.

A second area of research would be to better understand the role of innovation zones in regional development. The current research project did not look at the broader regional influences on the development of innovation zones, such as the industrial and business structure in areas surrounding the innovation zone, or the role innovation zones might play in regional development efforts.

A third area of research would be to focus more on the perspective of companies operating in the zones, to understand a firm-level view of how innovation zones could help companies foster innovation capacity. One key question in this regard that emerged from this study was how to best foster linkages between academic institutions and companies to support innovation.

Fourth, the project highlights the importance of international collaborations, such as the innovation partnerships that have emerged between Canada and China, including the WIN-SUN-SIP nanotechnology collaboration and the investment offices and partnerships of ZGC. Further studies on these international innovation partnerships might contribute to a better understanding of ways to foster international innovation collaboration.

Finally, it would be interesting to compare these Chinese innovation zones with other successful industrial parks and innovation zones in other countries in the Asia-Pacific region, such as Malaysia's Kulim High-tech Park, to gain a deeper understanding of innovation and international collaboration in other areas of Asia and how it compares to the Chinese experience.

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