

SUPPORTING
REPORT
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2035

CHONGQING

An Innovation Strategy to Climb Up
the Value Chain and Create the Conditions
for a Skilled Labor Force

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Table of Contents

1. Introduction	2	FIGURES	
2. Current Trends and Key Issues	3	Figure 1. R&D Expenditure in Chinese Cities	3
3. Lessons from Global Cities	5	Figure 2. R&D Expenditure of Industrial Enterprises above a Designated Size in 2015	3
4. Recommendations	7	Figure 3. R&D Expenditure as a Share of GDP	5
Innovation transformation I Boost the city's capacity for innovation	7	TABLE	
Innovation transformation II Build a large skilled workforce by strengthening vocational education to expand the technical knowledge of the labor force	7	Table 1. Number of Higher Education Institutions and Research Institutes in Major Chinese Cities	4
Innovation transformation III Take advantage of Chongqing's large consumer market and make the city a test-bed for innovative products and technologies	9	BOXES	
Innovation transformation IV Cultivate a creative industry and provide entrepreneurial spaces for the development of small and medium enterprises	9	Box 1. Innovation Strategy Key Messages	2
References	10	Box 2. Synergies between Universities and Start-Ups Ecosystems in Global Cities	6
Endnotes	11	Box 3. Germany's Dual Education System	6
		Box 4. Shenzhen's Strategy to Attract Innovative Companies and Talent	8
		Box 5. Why Apple Prefers to Make Its iPhones in China	8
		Box 6. London's Creative Industries	9

1. Introduction

The innovation economy has become a driving force in transforming entire industries, often at an accelerated pace. Cities are making massive investments in innovation and research and development (R&D) to support and attract technology-driven industries that are leading the digital revolution and disrupting established markets. To succeed in this transformation, a strong and skilled labor force is the most crucial factor. Human capital, meaning the skills, knowledge, and experience of the labor force, is critical for future economic development and innovation (Quintini 2014).

Traditionally, Chongqing has been a city of production, focusing on the application of technology rather than its development and innovation. However, while this has served the city well in the past, Chongqing's low innovative capacity puts it at risk of missing out on future economic opportunities. This problem is exacerbated by a shortage of highly skilled labor and by a mismatch between available jobs and the existing workforce.

BOX 1 Innovation Strategy Key Messages

Current trends and key issues:

- Investments in R&D, both by the Chongqing Municipal Government and by local firms, lag behind China's other three provincial-level cities.
- Chongqing lacks leading universities and research laboratories.
- The city's unbalanced labor market and a shortage of highly skilled labor could hinder it from climbing the value chain.

Benchmarking with global cities:

- Unlike global cities, Chongqing lacks an ecosystem for creative businesses and innovation, which requires top-tier universities, innovation-intensive enterprises, and a start-up scene.

Recommendations:

- Boost the city's capacity for innovation. In the short term, Chongqing should aim to attract

talent by enhancing its talent-seeking programs; in the long term, the city should aim to develop its own talent by developing world-class universities to create the right skill mix.

- Build a large skilled workforce by strengthening vocational education to expand the technical knowledge of the labor force. Following the example of Germany's dual education system, Chongqing should aim to become China's center of excellence for vocational education.
- Take advantage of Chongqing's large consumer market and make the city a test bed for innovative products and technologies.
- Cultivate a creative industry and provide entrepreneurial spaces for the development of small and medium enterprises.

2. Current Trends and Key Issues

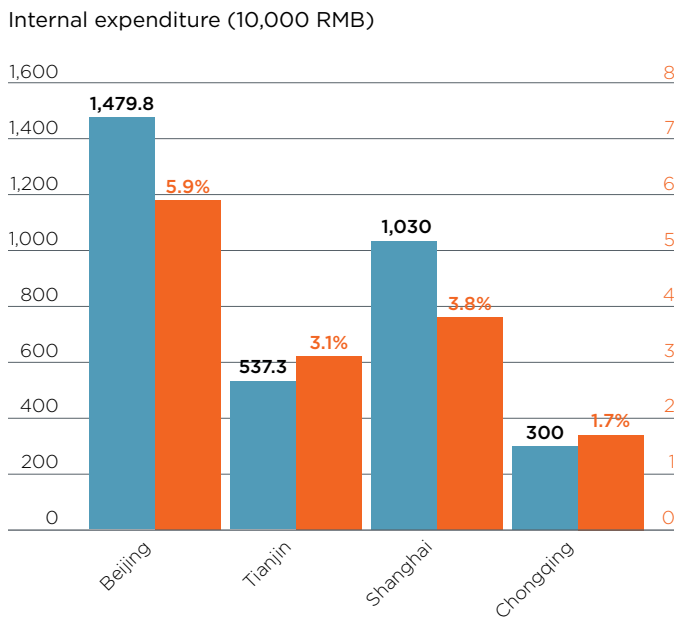
Chongqing's R&D expenditure constitutes only a small share of its GDP. Chongqing lags behind China's three other provincial-level municipalities in terms of R&D spending in total and as a share of GDP. While Beijing and Shanghai spend 5.9 percent and 3.8 percent of GDP on R&D respectively, Chongqing spends only 1.7 percent (figure 1) (National Bureau of Statistics of China 2016).

R&D expenditure among Chongqing's industrial enterprises is relatively low. The amount of R&D expenditure by industrial enterprises above a

certain size in Chongqing ranks last among China's four municipalities, and it is less than half that of Shanghai (figure 2). This is a key factor, given that most innovation is driven by private sector participation in research.

Chongqing lacks strong universities and research/innovation labs. There are only 72 colleges and universities in Chongqing, of which less than half have R&D activities. Furthermore, the city has far fewer research institutes than other major Chinese cities (table 1).

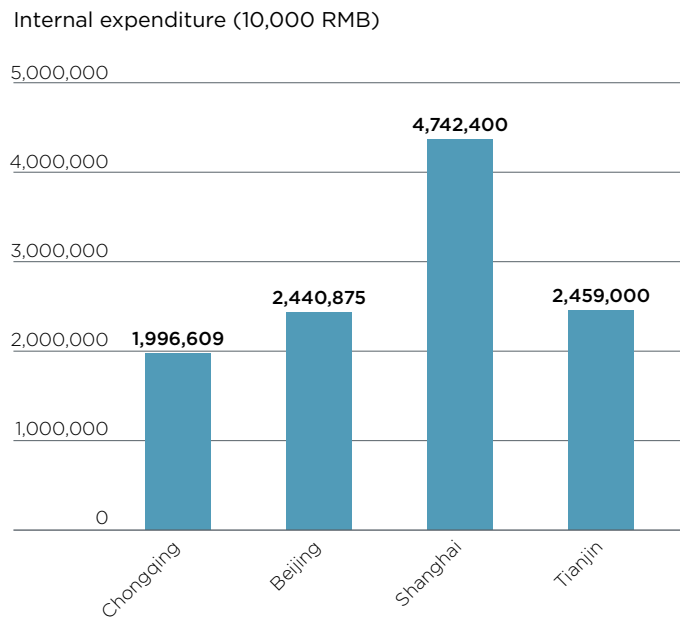
FIGURE 1 R&D Expenditure in Chinese Cities



● R&D expenditure
● R&D expenditure as a proportion of GDP

Source: National Bureau of Statistics of China 2016.

FIGURE 2 R&D Expenditure of Industrial Enterprises above a Designated Size in 2015



Source: National Bureau of Statistics of China 2016.

TABLE 1 Number of Higher Education Institutions and Research Institutes in Major Chinese Cities

	Beijing	Shanghai	Guangzhou	Chongqing
Higher education institutions	92, including Tsinghua University, Peking University, and Renmin University	64, including Fudan University, Shanghai Jiao Tong University, and Tongji University	83, including Sun Yat-sen University, South China University of Technology, and Jinan University	64
Research institutes	100, including Chinese Academy of Sciences, China Center of Advanced Science and Technology, and Chinese Academy of Geological Sciences	Over 80, including Shanghai Institute of Biological Sciences, Shanghai Materials Research Institute, and National Center of Protein Science	40, including Guangzhou Institute of Geochemistry, South China Sea Institute of Oceanology, and Institute of High Energy Physics—all affiliated with Chinese Academy of Sciences	27

Source: Shenzhen Municipal Government 2018.

There is a notable shortage of highly skilled employees, and the city also suffers from a mismatch of talent and jobs. In 2016, Chongqing had a working-age population (aged 15-64) of 21.62 million, or 63.7 percent of the city's *hukou* population. In 2016, the average duration of schooling for the population aged 15 and above was only 9.76 years, which is low compared to other municipalities in China (Chongqing Bureau of Statistics n.d.).

Moreover, the city suffers from a mismatch of talent and jobs. For example, the IT industry offers the highest ratios of job openings to job seekers with minimum qualifications, with ratios close to parity between applicants and openings. However, there

is only one opening for every three graduates of vocational schools, and the situation gets worse for university graduates, with roughly 1 opening for every 7 applicants (Chongqing Technological Development Strategy Institute and Chongqing Productivity Development Center 2017).

This mismatch represents a waste of human capital and may come at a cost to Chongqing's economy. By underutilizing its college and vocational school graduates in its high-tech industries, Chongqing indicates that it is not preparing for the pervasive employment transformations that robotics will bring to its industries.

3. Lessons from Global Cities

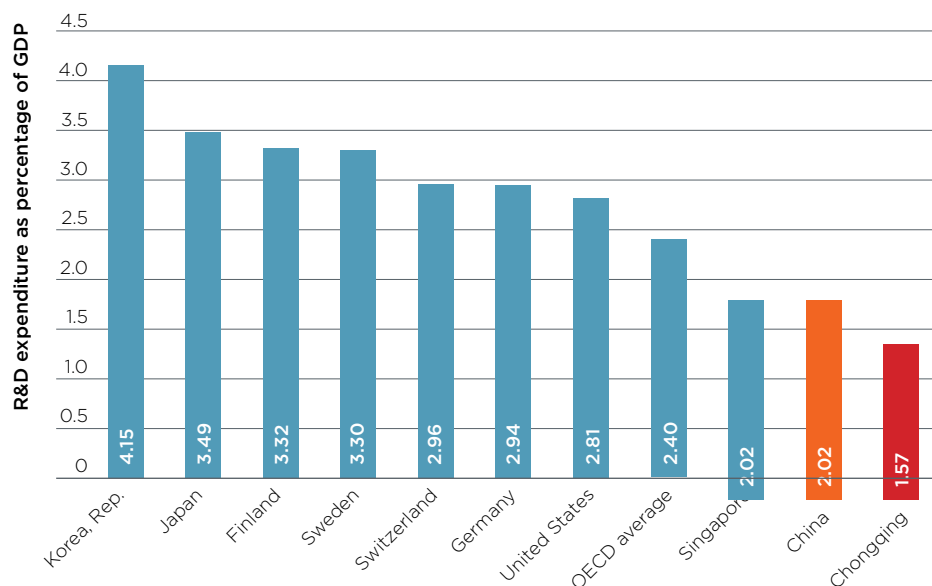
International experience shows that when a region's or country's R&D expenditure accounts for less than 1 percent of its GDP, its ability to innovate is very weak. A GDP share of 1-2 percent indicates a certain ability to innovate, and a GDP share of 2-5 percent indicates a strong ability to innovate. This suggests that Chongqing has a low baseline to start and that it must strengthen its R&D activities going forward (figure 3).

Technological innovation and high human capital give rise to innovative cities and their accession to the status of global cities. These cities combine a vibrant knowledge economy with top-tier universities and have a dominant innovative sector developed around a university of excellence (box 2). Their major universities have close links to large enterprises and develop innovative solutions using start-up incubators to promote their growth.

While technology is disrupting the labor landscape, there is a general shortage of highly skilled labor in many cities. According to the Organisation for Economic Co-operation and Development (OECD), 40 percent of European employers reported in 2013 that they had difficulties finding people with suitable skills (OECD 2016). This shortage was most common in the manufacturing sector.

For a production center like Chongqing, closely associating the practice of business applications in enterprises with learning can improve student training and help the city's workforce to develop the skills needed for the next stage of industrialization. To develop high-level technical skills among its population, Chongqing can learn from Germany's dual education system, which enables students to acquire a wide range of knowledge and applicable skills (box 3).

FIGURE 3 R&D Expenditure as a Share of GDP



Source: Produced by the Urban Morphology and Complex Systems Institute for this report, based on Chongqing Municipal Bureau of Statistics and NBS Survey Office in Chongqing 2016 and the World Bank 2018.

BOX 2 Synergies between Universities and Start-Ups Ecosystems in Global Cities

Boston, home to some of the best universities in the world, including Harvard and MIT, is a global leader in biotechnology. Montréal has developed an ecosystem of start-ups in artificial intelligence thanks to Université de Montréal's robotics program. San Francisco, Los Angeles, Toronto, and Chicago are other examples of cities with well-established start-up ecosystems. All three have strong universities, high-profile companies with links to schools, and offer opportunities to entrepreneurs.

Source: Hales, et al. 2017; Dutta, Lanvin, and Wunsch-Vincent 2017; Jones Lang LaSalle 2016.

The development of Seoul, one of the most innovative and high-tech cities in the world, was the result of the synergy among its world-renowned higher education institutions and high technology. The city ranks fourth in the world in terms of patent applications, after Tokyo-Yokohama, Shenzhen-Hong Kong SAR, China, and San Jose-San Francisco. Seoul is attracting growing interest from international investors and multinationals seeking to exploit its highly skilled workforce and innovative culture.

BOX 3 Germany's Dual Education System

How did a country of 80 million people become a global leader in the automotive, mechanical, and chemical industries? Germany achieved this thanks to the quality and reliability of its industrial products and the high level of competence of its industrial workforce. This is one of the successes of the country's dual education system, which combines enterprise training with theory taught in public schools one or two days a week.

The joint educational responsibility between schools and businesses creates a synergy

Source: OECD 2016.

between study and work. It ensures the constant modernization of programs, as learning is constantly updated and follows the development of advanced technology and the needs of the economy. In addition, the dual education system has allowed Germany to maintain a low youth unemployment rate, produce a skilled workforce, and increase its economic competitiveness. Companies offering training programs employ 70 percent of the German workforce, and 100 percent of apprentices get a job after completing training.

4. Recommendations

Innovation, or “innovative development,” is one of China’s major national goals. The Chinese government intends to make the country a global leader in innovation by 2035. Cities like Chongqing have a key role to play in this vision, and are expected to become hubs for advanced manufacturing and knowledge-intensive services.

Chongqing’s 13th Five-Year Plan has specific targets and indicators to assess achievements in innovation by 2020.¹ In particular, the plan aims for Chongqing to catch up with the OECD average by raising R&D spending from 1.57 percent of GDP in 2015 to 2.5 percent in 2020. It also calls for increasing the number of R&D staff per 10,000 employees by 66 percent (from 36/10,000 to 60/10,000) and growing the number of high-tech and new-tech enterprises from 1,035 to 3,000. The share of knowledge-intensive services in the regional domestic product is targeted to rise to 20 percent in 2020 from 16.3 percent in 2015 (Chongqing Municipal People’s Government 2016).

A strategy that prepares Chongqing for this transition to a knowledge-based economy will require four innovation transformations.

Innovation transformation I

Boost the city’s capacity for innovation

Improving a city’s capacity for innovation is a long-term endeavor. Compared to other more established cities, Chongqing is unlikely to create world-class universities within a short period of time. While the municipal government should increase R&D funding, encourage R&D expenditure among its companies, and lay out a long-term plan that builds high-quality clusters of universities, Chongqing should also identify solutions that address the current gaps. Overall, Chongqing should develop a strategy that combines short and long-term solutions.

The short-term strategy should include developing policies to attracting innovative entities and talent to Chongqing; the long-term strategy should include building world-class universities and technical research centers. In this regard, Chongqing can draw lessons from the success of Shenzhen, a “young” city that has adopted a similar dual strategy to make up for the shortfall of established universities in the city (box 4).

Innovation transformation II

Build a large skilled workforce by strengthening vocational education to expand the technical knowledge of the labor force

Chongqing is rich in human capital. By strengthening vocational education, the city can transform its workforce into highly qualified human capital, which is in demand among high-end industries. To move up the value chain and develop advanced industrial applications, Chongqing needs both senior white-collar workers with the latest knowledge of global markets, as well as blue-collar workers with high levels of technical skill. Future advances in the manufacturing industry will require the production of highly refined goods; hence a large number of skilled craftsmen will be needed. To encourage more children from urban families to enter vocational schools, the bias against vocational education needs to be addressed. Several measures can be introduced to achieve this objective, such as the creation of high-level technological universities, increases in funding, the expansion of teaching staff, and the updating of teaching materials. To emulate Germany’s success in the manufacturing industry (box 3), and ensure the development Chongqing’s manufacturing industry, the improvement of vocational education is crucial.

BOX 4 Shenzhen's Strategy to Attract Innovative Companies and Talent

Shenzhen, a city of 12.5 million people, is one of the most innovative cities in China. However, as a “young” city, it has only two major universities and three key research centers, unlike adjacent Guangdong Province, which has 83 universities and 40 research centers.² By finding a balance between its urgent priorities and its long-term plans, Shenzhen has successfully developed an ecosystem of creative industries and technological innovators.

Source: Shenzhen Municipal Government 2018

First, the Shenzhen Municipal Government formulated a long-term plan for the development of higher education in science and technology. However, it acknowledged that the problem could not be solved in the short term. By cultivating an open environment, the city attracted and encouraged institutions and talent from other regions and made rapid progress in scientific and technological innovation.

BOX 5 Why Apple Prefers to Make Its iPhones In China

At the Fortune Global Forum in Guangzhou in early December 2017, Apple CEO Tim Cook outlined the three key reasons why Apple manufactures its iPhones in China: the availability of millions of highly skilled workers, tooling engineers, and software developers; its unique ecosystem combining craftsmanship, robotics, and computers; and the presence of firms with capabilities in technological process co-development.

“The number one reason why we like to be in China is the people. China has extraordinary skills. And the part that’s the most unknown is there’s almost 2 million application developers in China that write apps for the iOS App Store. These are some of the most innovative mobile apps in the world, and the entrepreneurs that run them are some of the most inspiring and entrepreneurial in the world,” Cook said.

Source: Leibowitz 2017.

For Cook, China has a unique technological ecosystem: “China has moved into very advanced manufacturing, so you find in China the intersection of craftsman kind of skill, and sophisticated robotics and the computer science world. That intersection, which is very rare to find anywhere, . . . is very important to our business because of the precision and quality level that we like.”

Companies like Apple are looking for co-development in engineering and development. As Cook states, there is significant interaction between Apple and the Chinese manufacturers: “The process engineering and process development associated with our products require innovation in and of itself. Not only the product but the way that it’s made, because we want to make things in the scale of hundreds of millions, and we want the quality level of zero defects.”

The Apple CEO Tim Cook sees in China's vast supply of highly skilled vocational talent as the key reason for the country's success: "The vocational expertise is very deep here, and I give the education system a lot of credit for continuing to push on that even when others were de-emphasizing vocational. Now I think many countries in the world have woken up and said this is a key thing and we've got to correct that. China called that right from the beginning" (Leibowitz 2017).

For high-tech companies like Apple, China is no longer seen as an assembly line with cheap manpower but as a place where skilled labor is abundant and technological solutions can be co-developed with local firms (box 5).

Innovation transformation III

Take advantage of Chongqing's large consumer market and make the city a test bed for innovative products and technologies

Chongqing may not become a major cradle of innovation in the near future, but it could be an attractive location for the development and manufacture of innovative products. In December 2017, this strategy was implemented by eight cities

along the Yangtze River that established an alliance and platform for technological innovation sharing. If scientific and technological achievements cannot find an industrial chain locally, the cities can collectively implement projects. Similarly, Chongqing can rely on the sharing of innovations from other regions through transplantation and transform them to create local value.

Innovation transformation IV

Cultivate a creative industry and provide entrepreneurial spaces for the development of small and medium enterprises

In recent years, entrepreneurial spaces have flourished in Chongqing. These now number about 600, including those under construction. Allowing access to markets, professional services, and finance channels, these spaces offer affordable, practical, and comprehensive services for entrepreneurs. It is important to note that innovation players in the creative industries are mostly small and medium-sized enterprises that could complement the structure of Chongqing's scientific and technological industries (box 6).

BOX 6 London's Creative Industries

London's creative industries are significant contributors to the economy.³ In particular, IT, software, and computer services, which represent the largest share of the creative sector, contributed to 38 percent of its gross value added (GVA) in 2015 and more than half of its growth since 2009. This sector of the economy is concentrated in a few neighborhoods, which produce about half of the country's GVA in creative industries, and as such benefit from agglomeration forces and transfer of knowledge.

With a GVA of US\$62 billion in 2015, creative industries account for 11 percent of the London economy and 11.9 percent of its jobs. This sector benefits from productivity gains related to the clustering of creative businesses and workers. According to the Greater London Authority, the GVA per job in London's creative industries was US\$105,400 in 2015—22.2 percent above the average for all sectors. Furthermore, the most productive sectors tend to be in knowledge-intensive and tradable activities. Finally, this productivity translates into wages that are almost one-third higher than the average wage outside creative industries in 2016.

Source: Rozario 2017; Bakhshi and Mateos-Garcia 2016.

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Endnotes

1. To enhance Chongqing's technological innovation capacity, the 13th Five-year Plan of Chongqing for Technological Innovation sets out the overall objective of Chongqing becoming an innovation-oriented city, with three qualitative targets: (1) an innovation-oriented economic structure; (2) regional innovation capacity enhancement; and (3) innovation ecosystem optimization. These targets are based on 10 quantitative indicators, actioned through nine priority tasks for technological innovation in a number of sectors, including advanced manufacturing, new information, health, new materials, new energy, modern agriculture, eco-environmental protection, new urbanization, and public security (Chongqing Municipal People's Government 2016).
2. Shenzhen was a market town of 30,000 people in 1980 when it became China's first Special Economic Zone (SEZ). In 2017, after 37 years of sustained growth, it reached 12.5 million inhabitants and its GDP surpassed that of Guangzhou and Hong Kong SAR at US\$338 billion, placing it third in China behind Shanghai and Beijing.
3. The GVA of London's creative industries has increased by 38.2 percent in nominal terms since 2009, compared to 30.6 percent across all sectors.

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