MEASURING THE GROWTH OF SCIENCE AND TECHNOLOGY INNOVATION IN SHANGHAI

An index developed to evaluate the SCIENCE AND TECHNOLOGY INNOVATION CAPACITY of Shanghai shows the city rapidly advancing, while shedding light on future challenges.

In 2015, when plans were laid to make Shanghai a leading science and technology innovation centre, a research team was organised at Shanghai Institute for Science of Science (SISS) to develop a set of indicators to help monitor and evaluate Shanghai's performance. The result has been an index system, first released in 2016, that enables both international and longitudinal comparisons of Shanghai's innovation capacity.

At the 2017 Pujiang Innovation Forum, the newest 'Shanghai Science and Technology Innovation Centre Index Report', which assesses Shanghai's innovation performance between 2010 and 2016, was released. "The index, based on robust data analysis, offers a systematic and multi-dimensional approach to monitoring the construction of the science and technology innovation centre," said Luo Dajin, director of the SISS. "It helps us to identify Shanghai's strengths and weaknesses in innovation, guiding policy directions."

Assessing a city's innovation capacity

Cities that are global innovation leaders are typically characterized by: a high concentration of innovation resources that attract top talent; influential researchers and institutions that generate quality research; a friendly commercial environment with an open culture; a knowledge-based economy conducive to the growth of emerging industries; and, close ties with global innovation networks driving development through international collaboration.

Based on these features, five capacities have been identified as essential to building a science and technology innovation centre of global influence. These form the basis for the innovation index and can be broken down further into 30 more specific indicators (32 in 2017). "Many of these indicators are directly comparable to globally used innovation metrics, while maintaining the alignment with the strategic development plans of Shanghai," said Luo. "They are also quantifiable indicators with available data."

For example, Shanghai's capacity to **concentrate innovation resources** can be measured via its financial and human resources, research and development (R&D) platforms and infrastructure. The core indicators are the total R&D expenditure as a percentage of GDP, the percentage of total R&D expenditure for basic research, and the number of R&D professionals working the equivalent to full-time per 10,000 people.

The capacity to generate **high impact research results** can be reflected by the number of high-profile scientists and research institutions, as well as by their creation of knowledge and technology. The core indicators here are the number of Patent Cooperation Treaty (PCT) applications and patents granted per 10,000 people.

An **environment supportive of innovation and entrepreneurship** can be represented by measures of the commercial environment, social culture and infrastructure, with the percentage of newly established enterprises being the core indicator.

The **capability to support emerging industries** can be illustrated by measures of industrial competitiveness, the momentum of developments, and the employment rate for knowledge-intensive industries. The percentages of GDP contributed by the added value of knowledge-intensive service industries and by the added value of strategic emerging industries, as well as the overall labour productivity are core indicators.

The **spillover effect of innovation** can be measured by Shanghai's position in the global innovation network, technology exports and the global reach of local enterprises. The core indicator here is the percentage of the total value of technology contracts from outside of the city or country.

Shanghai's accelerating innovation capacity

Using 2010 as a baseline, Shanghai's innovation index number has more than doubled from 100 to 224.9 in 2016, with an average annual growth of 14.5%, peaking in 2016 at 22.7%. The most prominent increase was in influential research results, which grew at an average annual rate of 16% from 2010 to 2016, and by 34% between 2015 and 2016. "This reflects the rising R&D capacity of Shanghai," said Luo.

As China rises as a global research powerhouse, both Shanghai's total and high-quality research outputs are also growing rapidly. The number of articles first-authored by Shanghai-based researchers reached 42,902 in 2016, a 24.1% increase from the previous year according to Science Citation Index (SCI) data. In 2016, researchers from Shanghai published 39 articles in some of the world's top journals—Science, Nature and Cell—accounting for one third of China's output published in these three top journals. Scientists in Shanghai have also made science and technology breakthroughs, ranging from genetic modulation, targeted therapy and regenerative medicine to the detection of dark matter, mimicry computers and the means to control aerosol pollutants.

Patent applications are also rising, with 35.2 patents per 10,000 people in 2016, second only to Beijing nation-wide. PCT patent applications grew from 735 in 2010 to 1,560 in 2016, primarily in medicine, electronic communication and organic biology. Many of the PCT patents are the result of international collaborations, distinguishing research coming out of Shanghai compared to other Chinese cities, such as Beijing and Shenzhen.

As a global commercial centre, Shanghai is well connected within the global innovation network. Overseas investment in the city's industries amounted to 8.6 billion USD in 2016, a 57.4% increase from 2015. Local enterprises have launched more than 160 overseas mergers and acquisitions, many in high-tech fields such as information technology and biomedicine.

The capacity to support emerging industries grew at an annual rate of 15.6% between 2010 and 2016. The information technology industry has surpassed finance to become the fastest growing tertiary industry in 2016, while artificial intelligence and electronic games companies are flourishing.

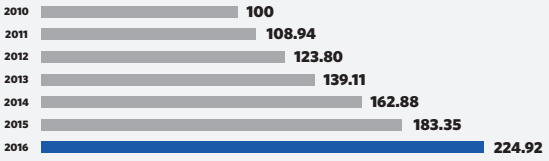
These improvements are attributable to increased innovation resources. The total R&D expenditure of Shanghai reached 104.9 billion RMB in 2016, an increase of 10% from the previous year, and accounting for 3.7% of the city's total GDP. Meanwhile, with the construction of the Zhangjiang Comprehensive National Science Centre, a cluster of advanced research platforms are sprouting, paving the way for larger-scale, international, cross-disciplinary collaboration.

However, the index report notes some challenges that Shanghai is facing. It shows that more top scientists are needed and a greater investment in basic research is required, the latter only accounted for 7.4% of total R&D investment in 2016. A lack of leading high-tech companies to drive technological innovation is also a challenge and requires a bolstering of the culture of entrepreneurship in Shanghai, as well as policies that further foster research-enterprise partnerships to transform research results into profitable products or technologies.

"We are rolling out new policies to promote the construction of science and technology innovation centre step by step," said Shou Ziqi, director general of the Science and Technology Commission of Shanghai Municipality. "We are optimistic that Shanghai will become globally recognized for innovation within the next 10 years." ■

INNOVATION INDEX NUMBER OF SHANGHAI, 2010-2016

Shanghai's innovation index number has more than doubled from 2010 to 2016.



CHANGE OF THE FIVE PRIMARY INDICATORS OF INNOVATION CAPACITIES OF SHANGHAI, 2010-2016

Shanghai's innovation capacities, as measured by the five key indicators, are growing rapidly between 2010 and 2016, with the most prominent growth in influential research results.