RESEARCH COLLABORATION DRIVES INNOVATION

Increasing international collaboration in Shanghai underpins the STRONG GROWTH OF RESEARCH OUTPUT IN THIS VIBRANT CITY, driving science and technology innovation.

With strong government commitment and continual increase in research input, China has become the world's second largest research powerhouse. This growth can be partly attributed to increasing international collaboration, a global trend in science.

In Shanghai, China's global economic centre and a leader in science and technology, collaboration and openness are setting the scene for innovation. A recent analysis based on Nature Index data, which tracks high-quality research published in top journals recognized by researchers, paints Shanghai's research output and collaboration picture, compared with the world's other top research producing cities, showcasing its growing capacity as a global science and technology innovation centre.

Growing research output

Based on articles published in 2017 in journals tracked by the Nature Index, Shanghai produces around 12% of the country's total output in the Nature Index. While it was still behind the world's top 10 cities in 2012, its fractional count, which calculates share of authorship, exceeded New York and the greater Boston area in the United States, as well as Paris and Tokyo in 2017, making Shanghai the second highest publishing city in the world as measured by the index. It lagged only behind Beijing, home to the Chinese Academy of Sciences (CAS), the world's largest research producing institution in the Nature Index. From 2012 to 2017, Shanghai has a 46% increase in the share of authorship and a 76% increase in article count, a growth rate higher than that of the world's most other major research producing cities.

By subject area, Earth and environmental science has the highest growth rate from 2012 to 2017, given its much lower base value in research output. In fact, output in all subjects has increased substantially in Shanghai from 2012 to 2017. As with the rest of China, chemistry is clearly the strength in Shanghai, accounting for more than half of its research output measured in fractional count, which is in contrast to other top research producing cities in the Nature Index, except Beijing.

Shanghai's academic institutions, including universities and their affiliated research centres, have contributed to most of its increases in research output. They account for 63% of the city's Nature Index output from 2012 to 2017, followed by government research institutions, such as those CAS institutes.

As a commercial centre, Shanghai also has 90 corporate institutions producing one or more articles in the Nature Index since 2012, exceeding the number of academic, government, or healthcare institutions contributing to the Nature Index in the city. This broad participation in research from corporate institutions demonstrates the dynamic forces that drive Shanghai's research capacity. "We encourage collaboration between our universities and enterprises," said Zhang Quan, director general of the Science and Technology Commission of Shanghai Municipality. "We want to see research results produced at our academic institutions translated into technological innovations that can contribute to socioeconomic development."

Collaboration as the norm

Growth is also seen in collaborative research, both in terms of domestic and international collaboration. International bilateral partnerships in Shanghai have grown by 159% from 2012 to 2017, while inter-city domestic partnerships have increased by 164%. The number of bilateral partnerships formed is based on co-authorship on articles tracked by the Nature Index.

Looking at article count, Shanghai's number of collaborative articles has doubled from 2012 to 2017, increasing by 90% for domestic collaboration, and by 106% for international collaboration. The proportion of internationally collaboration articles has increased from 45% in 2012 to 53% in 2017. Evidently, international collaboration has contributed considerably to Shanghai's rapid increase in research output and is dominating quality research publishing.

As science becomes more interdisciplinary and resource-intensive, collaboration is becoming the norm. International big science projects are also becoming more common. Aiming to be a leading research powerhouse, China is actively participating in, and also seeks to lead such global collaborations. The many international ties made between Shanghai institutions and their counterparts abroad, while demonstrating such a commitment, has led to growing research links. Meanwhile, the growing number of Chinese-born scientists returning from overseas also drives international collaboration, either with their former supervisors or colleagues abroad.

Unsurprisingly, Shanghai's top research producing academic institutions, such as Fudan University, Shanghai Jiao Tong University and East China Normal University, are also ranked among the top in their 2017 bilateral collaboration score, suggesting the role of collaboration in driving their high quality research output. This score is calculated by summing the fractional counts of the two institutions on papers to which both have contributed. The most active institution in international bilateral partnerships is NYU Shanghai, a joint venture in higher education between East China Normal University and New York University, which has most of its research output collaborated with its umbrella institution in the United States.

The United States is so far the biggest research collaborator for Shanghai. New York, Cambridge, Chicago, among others, are the top cities that Shanghai institutions collaborate with. Multilateral collaboration from Shanghai is the strongest with institutions in New York City. This is partially attributable to the three-way ties amongst NYU Shanghai, East China Normal University and New York University. In bilateral partnerships, Paris stands out as the top city that Shanghai institutions collaborated with. The Institut Pasteur of Shanghai, CAS has contributed greatly, given its close association with the Institut Pasteur in Paris.

Academic institutions in Shanghai tend to collaborate with cities in developed countries, such as the United States, UK, Germany and Japan. The exception is Tongji University, which has co-authored many papers with the UN Environment Programme, headquartered in Nairobi, Kenya. A joint institute for environment and sustainable development between the two institutions explains their close collaboration.

Joint research centres, institutes and schools are sprouting in Shanghai. Collaborative projects are also bringing more and more international researchers to the city. "We are glad to see the growing partnerships made between Shanghai institutions and their counterparts abroad, leading to increased research output," said Zhang. "We hope to broaden our collaboration and be more open, making Shanghai an ideal place for researchers around the world and a truly international science and technology innovation hub." ■