# Nature Index Analysis in Asia: Case Studies of China, India, Japan, South Korea, and Singapore (Postprint)

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## Abstract

This study takes China, India, Japan, South Korea, and Singapore in Asia as examples, comparatively examining scientific research innovation capabilities, advantageous disciplines, research efficiency, and international collaboration extent and partner countries as manifested in Nature Index data from May 2016 to April 2017, including article count, fractional count, and weighted fractional count. The study shows that China' s output of high-level research papers significantly exceeds that of other Asian countries, but its research efficiency is relatively low with unbalanced development across disciplines, and that China and Japan, as well as China and Australia, are mutually each other' s primary international collaboration partners.

## Full Text

### Analysis of Nature Index in the Asian Region: A Case Study of China, India, Japan, South Korea, and Singapore

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#### Abstract

This study examines China, India, Japan, South Korea, and Singapore in the Asian region by analyzing Nature Index data from May 2016 to April 2017, including Article Count (AC), Fractional Count (FC), and Weighted Fractional Count (WFC). The analysis compares research innovation capacity, dominant

disciplines, research efficiency, and the extent and partners of international collaboration. The findings reveal that China' s output of high-quality research papers significantly exceeds that of other Asian countries, though its research efficiency remains relatively low with unbalanced disciplinary development. China, Japan, and Australia serve as each other' s primary international collaboration partners.

**Keywords:** Nature Index, Article Count, Fractional Count, Weighted Fractional Count, high-quality research output

## Introduction

Nature Publishing Group launched the Nature Index (NI) in late 2014 as a comprehensive global indicator of high-quality research, selecting 68 top-tier, peer-reviewed academic journals with disciplinary representation for tracking [**?**]. Unlike its earlier Nature Publishing Index, NI' s monitoring scope is not limited to Nature Publishing Group's own publications. The index tracks author affiliation information from approximately 60,000 high-quality research papers, covering over 20,000 research institutions and universities worldwide, and has attracted widespread attention from domestic media and scholars since its release [**?**]. Based on NI statistics [**?**], this paper analyzes innovation trends, capacity, dominant disciplines, and collaboration potential among five Asian countries —China, India, Japan, South Korea, and Singapore—to provide references for China' s scientific research and innovation efforts.

## Overview of the Nature Index

The Nature Index (NI) is built upon 68 top international academic journals selected by an independent panel of experts based on recommendations from the academic community [**?**, **?**]. Although these 68 journals represent less than 1% of those included in the Journal Citation Reports (JCR), they account for nearly 30% of total citations in JCR. Nature Publishing Group employs three statistical methods—Article Count (AC), Fractional Count (FC), and Weighted Fractional Count (WFC)—with regular updates based on 12-month tracking periods.

In AC accounting, each author affiliation receives one AC point regardless of whether a paper has one or multiple authors. FC considers the relative contribution of each author, with the total FC value for any article equal to 1, shared equally among all authors assuming equal contribution. For example, a paper with ten authors assigns each author an FC score of 0.1. If an author has multiple affiliations, their FC score is further divided equally among those institutions. WFC modifies FC weighting to adjust for the overrepresentation of astronomy and astrophysics papers—two fields with four journals in the NI that account for approximately 50% of international journal publications in these disciplines, roughly five times the proportion of other fields. Consequently, under WFC, papers from these four journals receive a weight of 1/5 compared to

other papers.

### Analysis of Nature Index in Major Asian Countries

Analyzing AC, FC, and WFC indicators for the five Asian countries provides a novel perspective for observing high-quality research output capacity, dominant disciplines, international collaboration patterns, and research efficiency, offering valuable insights for research management.

**China's Leading Position in Research Output** According to NI statistics on papers from the 68 source journals for major Asian countries (for the full year 2016), China's research output far exceeds that of Japan, South Korea, India, and Singapore, accounting for over 50% of the regional total and ranking first in Asia. Japan's output is lower than China's but substantially higher than South Korea, India, and Singapore. South Korea's output is slightly higher than India's, while Singapore's output is relatively low at approximately 7.3% of China's [Figure 1: see original paper].

**Research Efficiency Comparisons** Li Guojie argues that research output quantity should not be overemphasized at the expense of quality and actual impact, as innovation is essential for high-value output [**?**]. Leydesdorff and Wagner's analysis of major industrial countries in Europe and other regions demonstrates a positive correlation between research investment and output [**?**]. Therefore, analyzing per capita high-quality research output can roughly indicate a country's research innovation efficiency. Comparing research paper output with researcher numbers across major Asian countries reveals that Singapore has the highest research efficiency, with nearly 11 WFC papers per 1,000 researchers in 2016. Japan and China show similar efficiency levels at approximately 4 papers per 1,000 researchers each, while India and South Korea have relatively lower efficiency at about 3 papers per 1,000 researchers [Figure 2: see original paper].

**Disciplinary Development Patterns: Commonalities and Differences** Analysis of high-quality research output in physics, chemistry, earth sciences, and life sciences among the five countries illuminates their dominant disciplines and development balance , supporting "knowing oneself and knowing others" for targeted collaboration.

In 2016, WFC statistics for major Asian countries by discipline [Figure 3: see original paper] indicate: (1) Asian countries generally show higher research output in physics and chemistry than the global average, while earth science and life science output is slightly below global averages, suggesting widespread emphasis on physics and chemistry across the region; (2) In physics, South Korea has the highest proportion of research output, followed by India and Japan, all exceeding 40%, while China's output is slightly below the world average; (3) In chemistry, China and India each account for over 50% of output,

significantly higher than other countries, with China' s share nearly double the world average, demonstrating clear advantages; (4) In earth sciences, South Korea and Singapore have the lowest proportions of high-quality research output, while China and India show similar proportions, though below Japan and the global average; (5) In life sciences, India, China, South Korea, and Singapore all have low output proportions under 20%, far below the global average.

Compared with global research output, Japan' s disciplinary distribution closely mirrors global patterns with balanced development across fields. China' s chemistry output far exceeds global averages, physics matches global levels, while earth sciences and life sciences lag below global averages, indicating unbalanced disciplinary development.

**International Collaboration Patterns** Comparing AC and FC values reveals a country' s collaboration approach: when AC significantly exceeds FC, external collaboration dominates; otherwise, internal collaboration prevails. AC/FC ratio analysis [FIGURE:4, TABLE:2] reveals four characteristics: (1) In physics and chemistry, China' s ratios are 1.73 and 1.23 respectively, lower than other major Asian countries and global averages, indicating domestic collaboration dominance. China' s earth sciences collaboration approximates global averages, while life sciences exceed global averages. (2) Japan' s foreign collaborator ratios across all disciplines are below 2, showing domestic collaboration dominance—a trend consistent with but far below global averages, reflecting strong independent innovation capacity. (3) South Korea and India emphasize domestic collaboration in physics and chemistry; their life sciences ratios slightly exceed global averages, indicating international collaboration dominance; South Korea' s earth sciences show stronger international collaboration than India. (4) Singapore shows marked inter-disciplinary differences: physics emphasizes domestic collaboration, while earth sciences and life sciences have foreign collaborator ratios approaching 3, far exceeding global averages.

Statistical analysis of the top 10 collaboration countries/regions by WFC value shows: (1) Among Western partners, the United States is the primary collaboration partner for all major Asian countries. The United Kingdom ranks as the second-largest partner for China and South Korea, and third-largest for India and Singapore. Germany is the third-largest partner for China, Japan, and South Korea. (2) Among non-Western partners, Japan serves as a major collaborator for other Asian countries, though ranking after Western partners. China is a primary collaborator for all countries except India. South Korea appears in the top 10 collaboration partners for Japan and Singapore. (3) China is the second-largest collaborator for Japan and Singapore, while Japan and Singapore rank 4th and 5th among China' s collaboration partners.

## Implications for China' s Research and Innovation

Analyzing other Asian countries' research efficiency, disciplinary balance, and international collaboration offers important insights for enhancing China' s sci-

entific and technological innovation capacity.

**Enhancing Research Efficiency While Expanding Output** China's high-quality research output has reached considerable scale, ranking first in Asia, but per capita output remains substantially lower than developed countries like Singapore. To maintain its leading position, China must further improve per capita research output. Innovation is the primary driver of development, requiring open-mindedness, awareness of academic trends, diligent summarization, and alignment with global scientific and technological development trends. Publishing in international high-impact journals represents the primary form of basic research output, though peer recognition and solution of important scientific problems require time to validate. While publication quantity offers one perspective on innovation capacity, citation rates provide another. Ultimately, innovation capacity manifests in solving key scientific problems—something not simply resolvable through bibliometrics alone.

**Strengthening Disciplinary Development and International Collaboration Strategically** Compared with Japan and global averages, China' s proportions of high-quality research output across disciplines show significant deviations. While consolidating dominant disciplines, China must pay greater attention to strengthening weaker fields to promote comprehensive, balanced disciplinary development and ensure interdisciplinary joint research and collaborative innovation for enhanced research output.

**The Critical Role of Talent and Global Engagement** National prosperity fundamentally depends on talent. To pursue innovation-driven development, China must prioritize attracting innovative talent. International cooperation and exchange facilitate knowledge and talent mobility. We can attract international talent at various levels—including international students, postdoctoral researchers, senior visiting scholars, and top foreign scientists—through research funding and talent recruitment programs. Simultaneously, we should encourage young Chinese researchers to collaborate and exchange with scientific powers, broadening their perspectives and enhancing innovation capacity.

Science and technology are global and era-specific; their development requires global vision and awareness of contemporary trends. While research innovation has become a national strategy, capacity enhancement is not achieved overnight but requires sustained efforts from the scientific community. Many scientific breakthroughs emerge at disciplinary edges or intersections, and interdisciplinary collaboration drives science toward deeper and higher levels, fostering innovative research outcomes.

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*Note: Figure translations are in progress. See original paper for figures.*