

STATE OF INNOVATION IN ASIA: KEY INDUSTRIES AND PLAYERS SHAPING ASIA'S INNOVATION ECOSYSTEM

Lead Analyst

Yuan-Sheng Yu
Senior Analyst

Contributors

Cort Isernhagen
Senior Vice President

Cosmin Laslau
Director, Research Products

questions@luxresearchinc.com

ABSTRACT: ASIA'S RECENT INNOVATION BOOM

Asia has driven a boom in innovation in recent years in terms of R&D spending, venture capital funding, academic publications, and patents. However, it is difficult to bucket the entire region's ecosystem into one category, as the population, economic status, and innovation strategy vary greatly.

Our unique methodology analyzes seven key industries to determine the Innovation Force and finds that China and South Korea emerge as innovation powerhouses as Japan solidifies itself as an innovation conservative. Singapore, Hong Kong, and Taiwan have carved out their niche roles as innovation specialists, while Indonesia, Malaysia, and Thailand are innovation generalists embarking on the next phase of their innovation journey. India has yet to differentiate itself as it struggles to keep pace with its regional peers.

TABLE OF CONTENTS

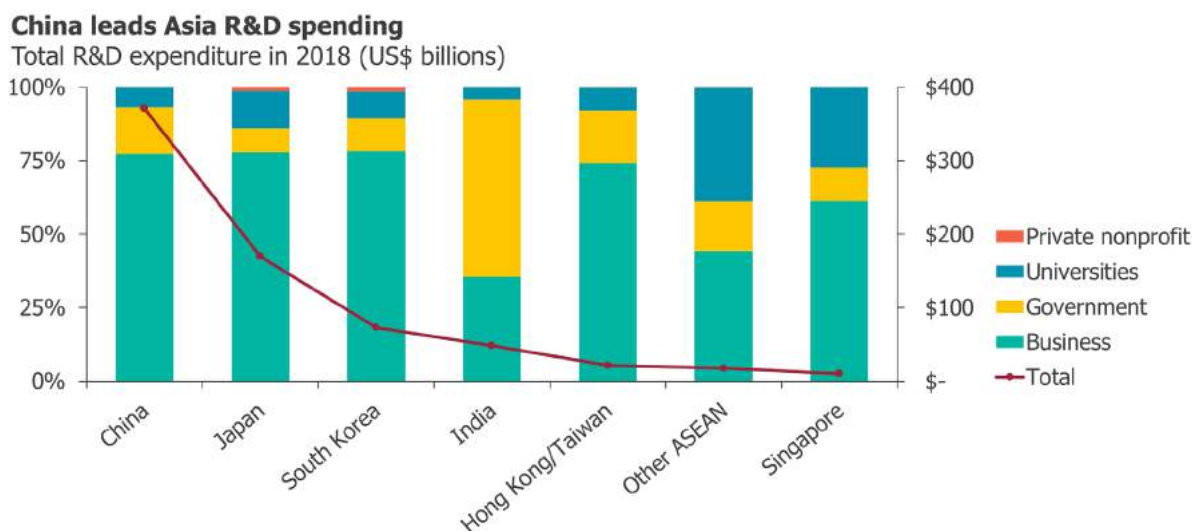
Asia's Recent Innovation Boom.....	2
The Innovation Force Shaping The Ecosystem.....	5
Innovation Powerhouses And Specialists.....	10
Outlook On Asia As A Global Innovation Hot Spot.....	12

ASIA'S RECENT INNOVATION BOOM

China, Japan, and South Korea combine to spend \$613 billion on R&D in 2018, taking three out of the top five global spots, along with the U.S. (No. 1) and Germany (No. 4). The private sector plays the primary role, making up approximately 78% of total R&D spending.

India's R&D spending is No. 7 globally and is largely supported by government spending, accounting for approximately \$29 billion or 60% of the total R&D spending. Hong Kong and Taiwan are second in government R&D spending, at 18% or \$4 billion.

The Southeast Asian nations combined spent \$28 billion on R&D, with the highest percentage of R&D spending originating from universities – 27% in Singapore and 38% in Indonesia, Malaysia, and Thailand.



China, Japan, and South Korea lead Asian countries in total R&D spending at \$613 billion in 2018

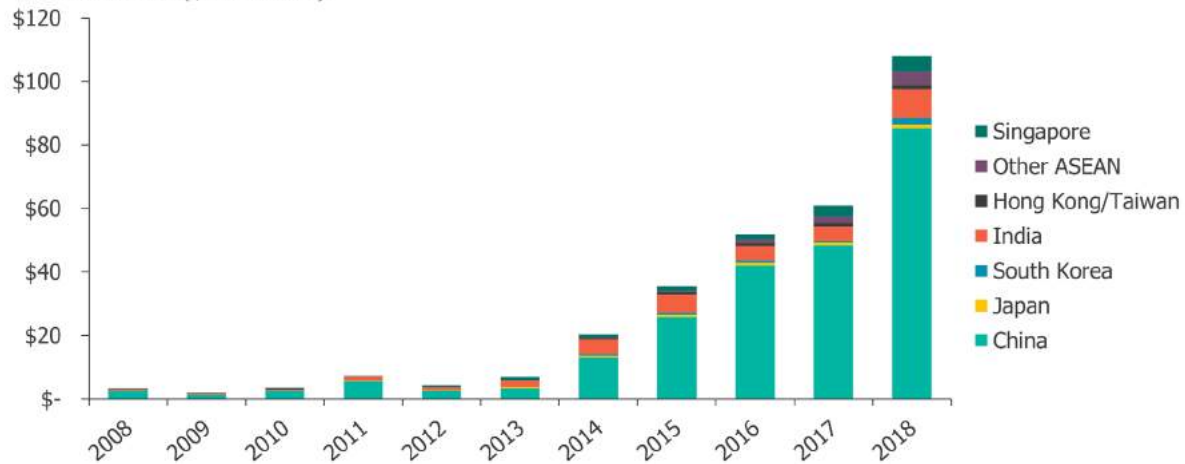
With more than \$85 billion in VC funding, China took the top spot globally from the U.S. in 2018. While China experienced an uptick from 2013 to 2017, 2018 was an exceptional year for China's VC scene, with nearly 1,900 deals at an average deal size of \$45 million.

India and Southeast Asia, primarily Indonesia and Singapore, entered the VC spotlight in 2017 with several high-profile funding rounds. With more than \$28 billion raised in the past two years, the three countries have spawned 19, four, and two unicorns, respectively.

Despite their reputations as innovation powerhouses, Japan and South Korea both lag behind their regional counterparts in VC funding. With the lowest amount of VC funding raised in the region, a strong domestic startup base is a major gap in both countries' innovation ecosystems.

Asian startups raise \$107 billion in 2018

Total VC raised (\$US billions)



More than \$85 billion in VC funding in China dwarfs the rest of the region despite rapid growth in India and Southeast Asia

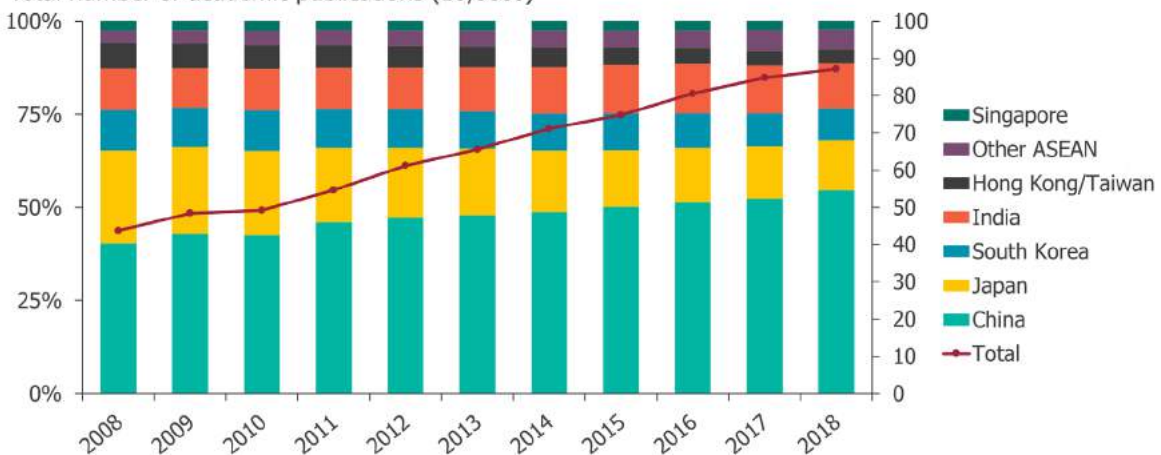
China's academic output is well-documented, with 48% of the region's total publications and a threefold increase in production since 2008. Despite only contributing 5% of the region's output, Indonesia, Malaysia, and Thailand's academic activity is picking up momentum, publishing nearly five times as much today as they did a decade ago.

Japan has quickly lost its share of the academic landscape, dropping from 28% of total publications in 2008 to 13% in 2018 as output has stalled to a near standstill. Only Hong Kong and Taiwan had a lower publication rate in the past decade.

India, Singapore, and South Korea have remained consistent, on average doubling their academic output since 2008 and now contributing approximately 25% of the region's academic studies.

Academic publications doubled in 10 years

Total number of academic publications (10,000s)

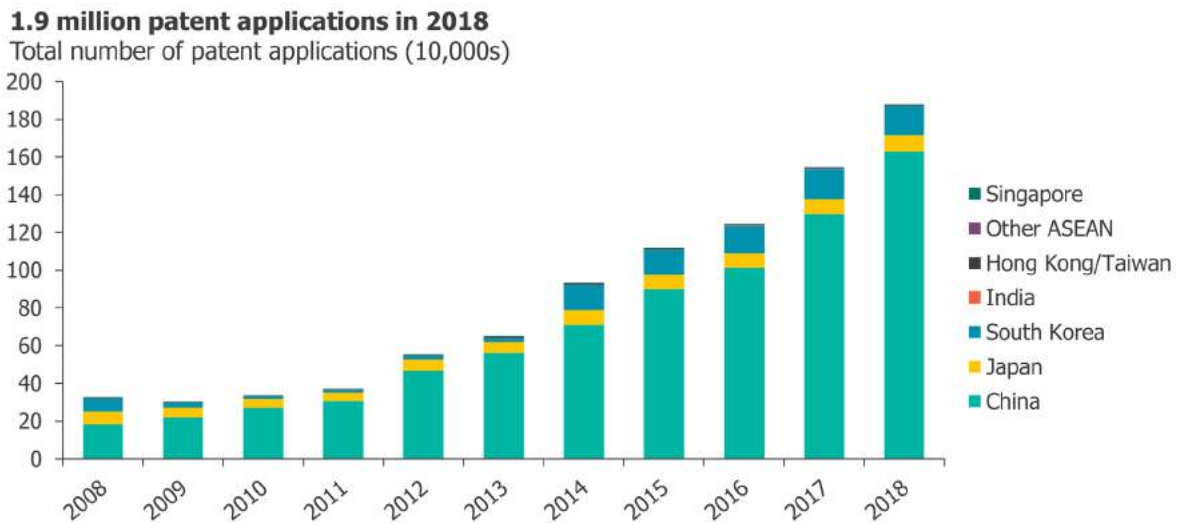


Academic publications top 870,000 in 2018, with research output more than doubling in the past decade

For the past decade, China has been the world’s leader in patent applications, and with 1.6 million patent applications in 2018, it has increased its output at a 24% annual growth rate since 2008. Since 2008, China’s share in Asia patent applications grew from 46% to 87%.

Japan and South Korea’s small, yet consistent, patent application output saw 3% and 8% annual growth rates, respectively.

India and Southeast Asia (excluding Singapore) see minimal patent application activity coming from even their largest domestic companies. While they have seen more than 10% annual growth rates in the past decade, the majority of patent applications continue to be submitted by locally registered foreign corporations.



Patent applications witness a nearly six fold increase since 2008 as China pulls away from Japan and South Korea

With innovation activity – R&D spending, venture capital funding, academic publications, and patent applications – increasing in Asia, the question remains, “How will this shape the region’s innovation ecosystem in the coming years?” The heterogenous nature of the region also adds a layer of complexity.

It appears that India will rely on government spending, Southeast Asia will leverage its academic institutions, Japan and South Korea will continue to drive innovation from their massive conglomerates, and China will look to tap its entire ecosystem. On top of all this, an increase in the number of startups, albeit currently unevenly distributed in Asia, brings a new variable into Asia’s innovation ecosystem that has not historically played such an influential role.

THE INNOVATION FORCE SHAPING THE ECOSYSTEM

For this report, we use a modified version of the methodology used by the World Intellectual Property Organization, Eurostat, and Clarivate Analytics to analyze patent data and trends. We utilize a combination of International Patent Classification (IPC) codes, key technology terms, and Kind codes to identify patent applications across seven key industries – chemicals and materials, consumer goods, energy, healthcare, heavy industry, information technology, and manufacturing. In this section, each industry is rated with a unitless and normalized score – which we term “Innovation Force” – that is designed to quantify the magnitude of innovation that is currently occurring within that industry. The Innovation Force is designed to take into consideration the historical body of work (total patent applications) and the rate of acceleration at which innovation activity is occurring (compound annual growth rate).

We use Lux’s internal patent analysis tools to conduct custom searches on the seven industries, focusing specifically on the country of the assignee, rather than the country in which the patent was filed for. For example, Alibaba’s patent for statistics-based machine translation (US20170124071A1) is considered under China despite the patent being filed for in the U.S. because Alibaba is a Chinese-headquartered organization. Because Innovation Force is both a unitless and a normalized metric, it has the capability to compare technologies, organizations, and countries head-to-head. In this section of the report, we use Innovation Force to compare the activity of the seven key industries against each other within each country. In the latter part of this report, we use Innovation Force to compare the overall activities of each country against each other.

CHINA

In recent years, China has ramped up its innovation efforts, as a new era of leadership under Xi Jinping pegged innovation as the primary force behind the country’s development and modernization – shedding its low-cost manufacturing reputation to become a key source of high-technology developments.

Integral to the country’s evolution is the 2015 strategic plan “Made in China 2025,” focusing its innovation roadmaps on next-generation information technology, robotics, aerospace and defense, maritime technology, advanced rail transportation, new energy vehicles, power equipment, agriculture technology, advanced materials, and pharmaceutical and medical devices.

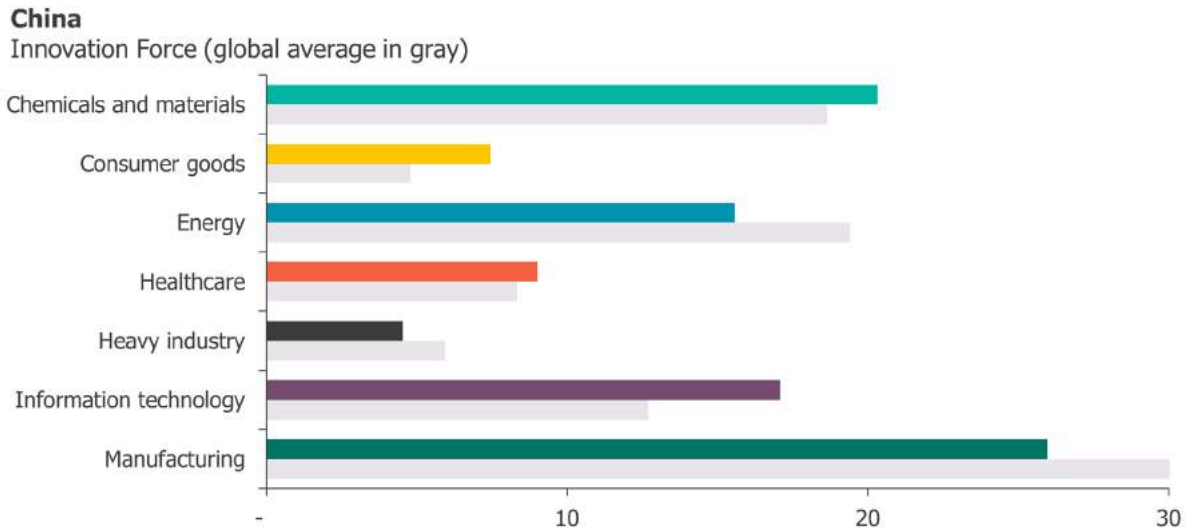


While the developments will come in phases well beyond the five-year time frame, China has fostered an environment ideal for innovation. From academics to entrepreneurs to corporates, the country is well-positioned to excel and take a global leading position in several key industries.

Manufacturing leads all industries, as advanced manufacturing is a key strategic initiative. Technologies like robotics and 3D printing are key areas of focus for domestic expertise as the country continues to ramp up its manufacturing capabilities and capacity.

Information technology ranks high, with China being a global leader in establishing a digital economy. The country has been very public with its ambitions of becoming the global leader in artificial intelligence in the next decade and is already a trailblazer in 5G technologies.

Pollution has stimulated significant clean **energy** developments in recent years, with the nation becoming the global leader in electric vehicles. But as China vies for energy security, technologies like nuclear energy, power transmission, and oil and gas exploration remain key focus areas.



Innovation Force is well-aligned with the near-term goals of Made in China 2025



Universities dominate the innovation ecosystem except for information technology and heavy industry

JAPAN

Japan has built a reputation as an innovation powerhouse over the course of the past several decades. It consistently ranks high on innovation leaderboards, and its companies make up 15% of the world's most prolific R&D spenders. But the country now faces severe headwinds with a rising aging demographic and vows that innovation will be the solution.

"Society 5.0" is at the root of the country's innovation strategy, developing an ultrasmart society driven by the ubiquitous integration of connectivity technologies and robotics into everyday life. Shinzō Abe believes Abenomics will be the driving factor behind realizing the country's innovation strategy through deregulation and fiscal stimulus.

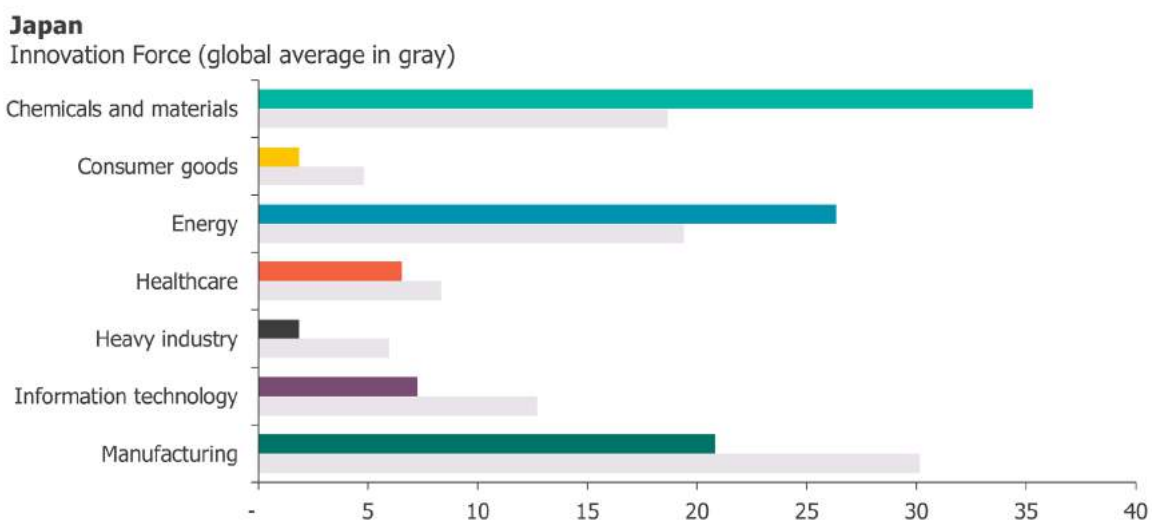
LUX TAKE

Despite efforts to parlay its historical R&D prowess into a new era of innovation, the country struggles to create an ecosystem that bridges academia and corporations. As the gap widens, Japan will lose its entrepreneurial and eventually innovation edge to its regional peers.

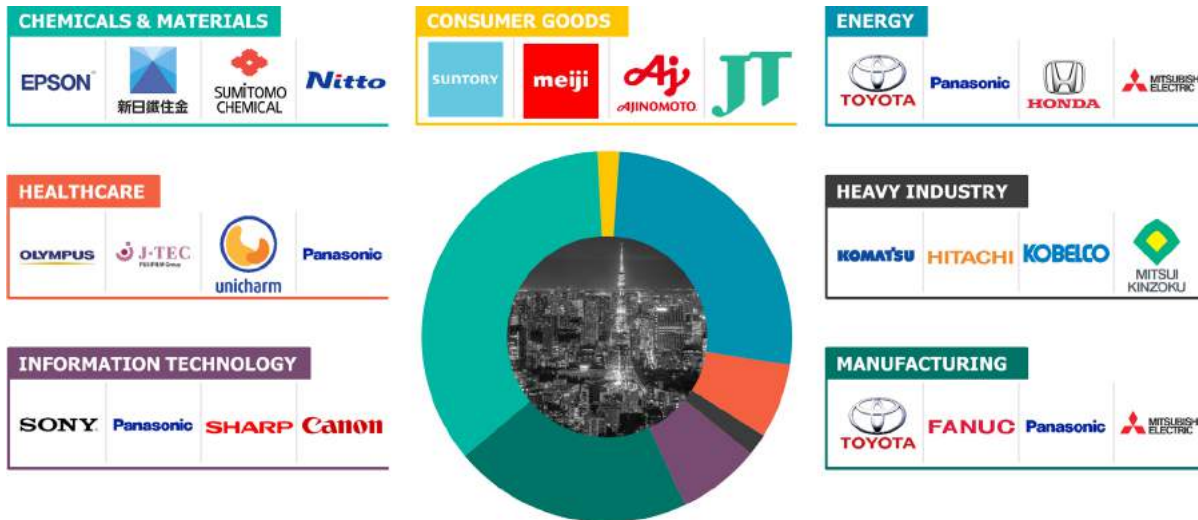
Chemicals and materials leads all industries, as it remains a core business for many of Japan's largest companies. Innovations in surface materials and coatings, polymers, and specialty chemicals are key areas of focus as the country continues to solidify its position as one of the global leaders in the space.

Energy is largely driven by the country's dominant position in the automotive industry. While there is a continued focus on incumbent ICE vehicles, the rise in electric vehicle development and the historical work on fuel cell vehicles are key to the country's automakers continuing to hold the top spots.

With the fourth-highest industrial robot density in the world, Japan continues to develop advanced **manufacturing** and automation technologies as it aims to improve workforce productivity levels for its aging population.



Innovation Force in leading industries does not fill all the technology gaps necessary to realize Society 5.0



Major corporations continue to be the catalyst, but also the cause, of a narrowly focused innovation ecosystem

SINGAPORE

Singapore is consistently in the conversation about the world's most innovative countries. A large factor is the strong government initiatives and organizations that have fostered an R&D ecosystem, as well as an established financial infrastructure that encourages academia, small and medium enterprises, and corporations to develop and test innovations.

Dating back to 1995 with the first National Technology Plan, the country has shaped its national strategy around developing itself into a global R&D hub. The most recent Research, Innovation, and Enterprise 2020 Plan has a \$19 billion budget, which primarily focuses on advanced manufacturing, health and biomedical sciences, urban solutions, and digital economy.

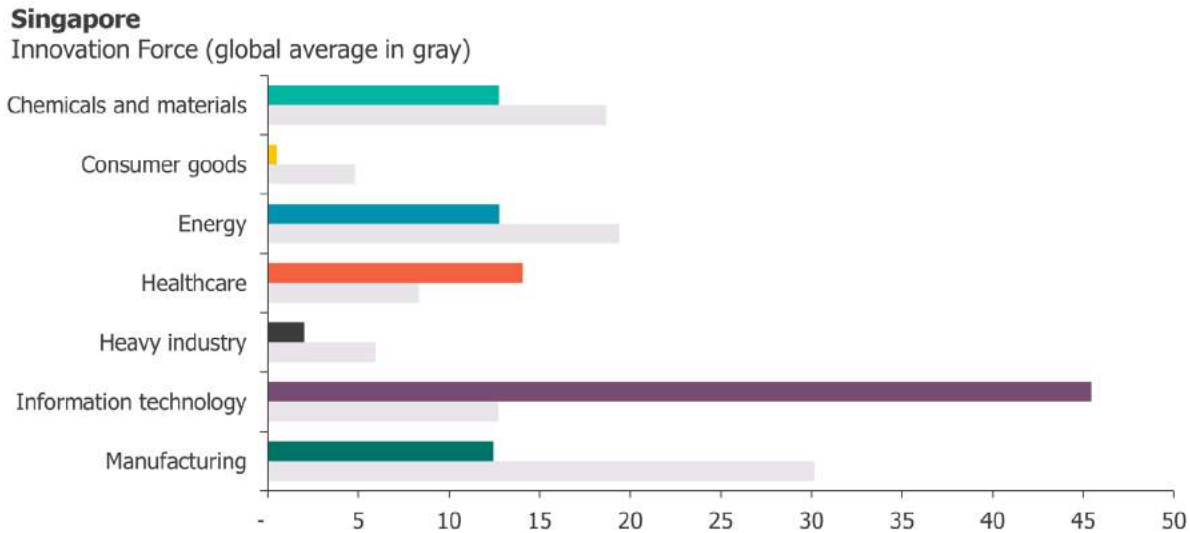
LUX TAKE

With its favorable social and economic factors, there is no doubt that the country will remain one of the world's top R&D hubs. However, it will soon face competition from its regional peers, which also look to attract top foreign innovation talent. In the near-term, Singapore's sophisticated innovation ecosystem will insulate it from any significant regional competition.

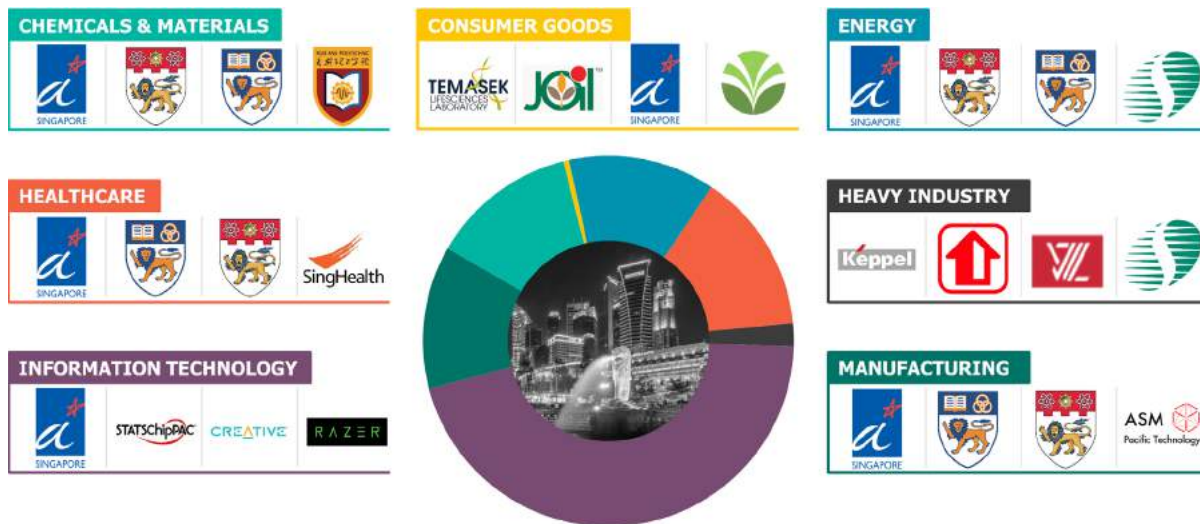
Information technology is more than three times higher than all other industries, as the semiconductor sector is a key part of the country's economy. Connectivity and financial technologies have witnessed a major boom, as Singapore is establishing itself as a global leader in the latter.

Healthcare is the second-highest industry, with several major players setting up strategic R&D labs to tap the local talent. Medical devices are the primary focus, but pharmaceuticals and biotechnology are quickly gaining traction.

With a strong R&D push in urban solutions and sustainability, **energy** technologies are key to achieving its Smart Nation initiatives. Water technologies remain core to its R&D strategy as expertise in energy and air quality management systems continues to grow.



Innovation Force is heavily focused on pushing technology development for a digitally enabled Smart Nation



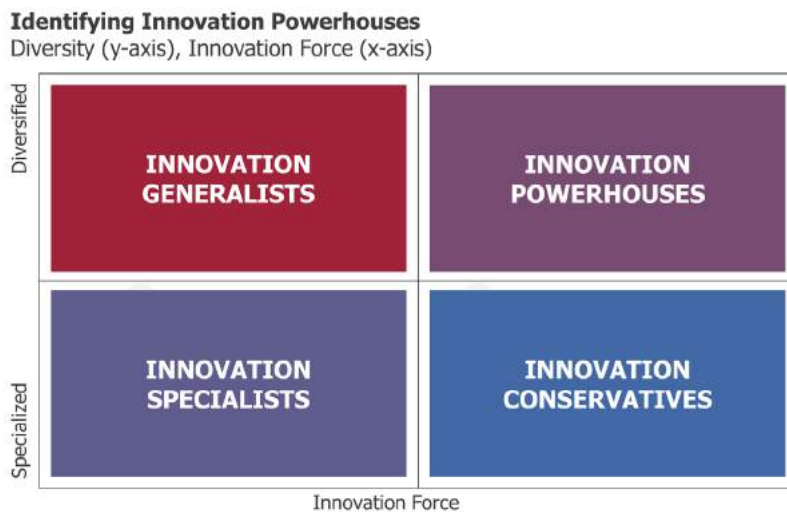
Research institutes are ubiquitous and serve as strategic R&D hot spots for global corporations

INNOVATION POWERHOUSES AND SPECIALISTS

Categorizing the state of innovation in each country is important for mapping out the landscape of the region as corporations scout for threats and opportunities for their respective industries. To analyze this, we looked at two key factors:

Innovation Diversity: How well-rounded is each country's innovation portfolio? We measured the Innovation Force for the seven key industries in each country to identify specialization at the expense of other industries.

Innovation Force: How strong is the Innovation Force of each country compared to the others? We measured the Innovation Force of the entire body of work for each country and compared them to each other directly. Note that the Innovation Force of a country can change based on the countries analyzed.



Identifying innovation powerhouses and specialists in Asia's dynamic ecosystem

The resulting visualization shows four quadrants that a country's innovation identity can fall into.

Innovation Generalists: Innovation levels are relatively low and broadly spread across several industries.

Innovation Powerhouses: Not only do these countries innovate at a high rate, they do so in many different industries.

Innovation Specialists: These countries have focused all their innovation, though low overall, in one or two key industries.

Innovation Conservatives: While innovating at a high rate, these countries focus their efforts in only a select few industries.

Identifying Innovation Powerhouses

Diversity (y-axis), Innovation Force (x-axis)



Identifying innovation powerhouses and specialized winners in Asia's ecosystem

China and South Korea possess the most robust and diverse innovation portfolios, easily separating the two countries from the rest of the region as prolific innovators. With increasing collaborations between the two, China can quickly fill technology gaps it may have while South Korea gains access to a market it seeks to find. This combination will only further strengthen the two countries' position regionally and globally.

Japan continues to be a major innovator, but its body of work has been consistently shrinking in terms of focus over the years. While it will remain home to some of the world's leading innovators for the foreseeable future, it has lost ground to China and South Korea in several key industries. Without significant changes to the innovation ecosystem and strategy of its main players, Japan will quickly innovate itself into a corner of specialization.

Singapore, Hong Kong, and Taiwan have solidified themselves as specialized innovators, and rightfully so. With population sizes that are a mere fraction of their regional neighbors, all three countries have strategically aligned their innovation efforts in key industries with economic development goals or with the human capital they possess.

Indonesia, Malaysia, and Thailand are innovation generalists today, but expect the three countries to carve out their own niche in terms of industries. With national innovation roadmaps underway and rapid economic growth, each of these three countries will likely come into its own in the coming decade.

India is a unique example, despite falling in the innovation specialist quadrant. Despite its massive population, it is positioned far left in our Innovation Force ranking as it struggles to keep pace with significantly smaller countries in the region.

OUTLOOK ON ASIA AS A GLOBAL INNOVATION HOT SPOT

INNOVATION REMAINS BOTTLED IN ACADEMIC LABORATORIES

Outside of Japan and South Korea, the majority of innovation is still driven by research institutes and governments, and university funding remains key in supporting innovation in the region. While Singapore is likely to continue to carve out its unique global role as an R&D hub, the remaining countries will need to incentivize the commercialization of their innovations by providing financial support, such as tax breaks and seed funding, and access to infrastructure – from working space to equipment. This approach has proven successful in the growth of China’s innovation ecosystem over the past decade.

TECHNOLOGY GAPS IDEAL FOR FOREIGN INNOVATORS

There are large technology gaps for several key industries in India, Indonesia, Malaysia, and Thailand. While domestic developments will likely ramp up as they roll out their innovation roadmaps, opportunities for foreign innovators to deploy their technologies and solutions will grow. Foreign entities are already active in these regions, especially chemicals and materials and energy, often being the driving force behind these national innovation efforts. With supportive policies regarding work visas and international collaboration, now is the time to cement your organization’s role in these emerging markets.


THE COPYCAT IS NOW BECOMING THE COPIED FOR INNOVATION

China is quickly becoming the nucleus for the region’s innovation landscape, with several pockets of specialization across the country. It is deftly addressing three fundamental areas as it develops its innovation landscape – clear national innovation strategies, promoting ideation, and nurturing a domestic ecosystem. At the same time, it is spreading its tech influence through traditional infrastructure development, establishment of innovation centers, and venture capital funding, serving as a catalyst behind much of Southeast Asia’s and India’s recent innovation rise.

THE SHIFT TOWARD THE EAST IS UNDENIABLE

Home to more than two-thirds of the world’s population, 31 megacities, and one-third of the world’s largest companies, Asia is quickly becoming the epicenter of the world. Combined with forecasts of it taking the majority of global GDP and 90% of the global middle class growth, the transition toward a new world order is underway.

The rise of Asia is a global phenomenon and ripe with opportunities for everyone, not just the regional players. For the past several decades, Asian organizations have benefited tremendously from expanding their innovation efforts abroad to the U.S. and Europe. The reverse can be equally profitable for foreign companies exploring similar avenues into Asia’s innovation ecosystem.



Lux Research is a leading provider of tech-enabled research and advisory services, helping clients drive growth through technology innovation. A pioneer in the research industry, Lux uniquely combines technical expertise and business insights with a proprietary intelligence platform, using advanced analytics and data science to surface true leading indicators. With quality data derived from primary research, fact-based analysis, and opinions that challenge traditional thinking, Lux empowers clients to make more informed decisions today to ensure future success.