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A COMPARATIVE STUDY OF INNOVATION PATHWAYS IN EAST ASIA: JAPAN, SOUTH KOREA, CHINA, AND TAIWAN

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A B S T R A C T

This study offers a comparative analysis of innovation strategies employed in East-Asia, with a specific focus on Japan, South-Korea, Taiwan, and China. By examining these models, we explore the factors contributing to Japan's recent challenges, while acknowledging the substantial efforts South-Korea, Taiwan, and China have produced. It uncovers key similarities and differences among these countries, laying the foundation for a nuanced understanding of regional dynamics.

Additionally, this article proposes a definition of innovation tailored to the East-Asian setting to capture the intricate interplay of cultural, societal, and economic factors, and introduces a personalized index of innovation, which considers the recent efforts introduced by each state, offering a comprehensive evaluation framework that allows for a holistic assessment of their innovation performance.

In conclusion, we offer insights for Japan's revival prospects. Drawing upon the successful strategies of these neighboring countries directed towards re-boosting Japan's position as a Global Innovation Leader.

1. INTRODUCTION

In the rapidly evolving innovation globally, East Asia has been performing as a key player, each state working on a piece to complete the full image of the world's technological advancement. As Japan, South Korea, China, and Taiwan have a strong presence in many of these areas, it is imperative to understand their strategies. This article presents a comprehensive exploration, offering a comparative analysis that uncovers both shared and distinct patterns.

By focusing on a comparative approach, our study contributes to a more comprehensive understanding of East Asia's innovation dynamics. It is not simply a collection of individual narratives but a full picture that demonstrates the interplay of strategies, industries, and cultural nuances that define the region. As we unravel the innovation strategies and metrics of East Asia, we invite readers to explore the recent approaches and performance of the region.

The existing literature provides valuable insights into the innovation efforts of these countries in different domains; however, some gaps were noted. While individual studies often focus on singular aspects of innovation in East Asian countries separately, a holistic comparative analysis encompassing the strategic focus and steps taken by each nation to attain technological advancement assessed collectively remains underexplored. Additionally, the absence of a unified definition of innovation tailored to the East Asian context obstructs a nuanced understanding of the region's dynamics. This article also introduces a personalized innovation index that recognizes the recent efforts initiated by each territory. Finally, the study singles out Japan with lessons to explore the opportunities and challenges of the region and take action to gain back its long-lasting position as the Innovation Hub of the world.

Research question

How is Japan positioned in the global innovation systems, and what strategies could be used to revitalize

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its innovation ecosystem based on the experiences of South Korea, China, and Taiwan?

Research Objectives

1. To evaluate the status quo of innovation in Japan and compare it with South Korea, China, and Taiwan using performance metrics such as patent filings, R&D spending, and global innovation rankings.
2. To inspect and compare the innovation pathways of Japan, South Korea, Taiwan, and China focusing on the innovation strategies employed.
3. To identify key similarities and differences in the innovation strategies of Japan, South Korea, Taiwan, and China, considering factors such as government initiatives, corporate strategies, and cultural influences.
4. To propose actionable recommendations for Japan to revive its innovation ecosystem.

2. LITERATURE REVIEW

2.1 Evolution of innovation in Japan

After the war, Japan immediately embarked on a path of recovery, a strategy that has been characterized by active government engagement as well as government-business collaboration (Holroyd & Coates, 2007c). Japan decided to invest heavily in basic science and focused on commercializing new discoveries and technologies, utilizing the National Innovation Systems: government research units, the private sector, and public universities collaboration (Holroyd & Coates, 2007c).

Japanese policy built an industry based on technology import and quality manufacturing, which has driven the growth of businesses' technological ability. Consequently, in the 1960s, the Toyota Production System revolutionized manufacturing processes worldwide (Womack et al., 1991). In the following period, Japan began emerging as a global leader in electronics with companies such as Toshiba, Sony, and Panasonic, establishing a significant innovation contribution reaching the economic bubble in the late 1980s, followed by a burst in the early 1990s. This period knew both excessive speculation and subsequent economic challenges (Katz, 1998). By then, Japan has chosen to start undergoing an important institutional transformation (*Analysis on the Transformation of Japanese Technological Innovation System*, 2005).

After the 1990s changes Japan continued leading in robotics and automation, with companies such as Honda and universities developing advanced humanoid robots (Takanishi, 2008), and increasingly Japan decided to enter the global collaboration and Open Innovation in addition to its internal knowledge to stay competitive, as a result, to focus on Artificial intelligence and Industry 4.0 from the 2010s (Lu et al., 2018).

Japan's national innovation system is distinctive, with a deep and extensive innovation system and relatively high R&D expenditures. It has unique institutional arrangements that support its success in key industries. (Goto & Odagiri, 1996; Jackson & Debroux, 2008).

2.2 Japan's stagnant innovation performance

Japan experienced a noteworthy slowdown in innovation. This is indicated by a decline in key metrics such as patent filings, research and development (R&D) investment, and global innovation rankings (Comin, 2008). Despite Japan's strong historical track record of technological innovation, its position as a global innovation leader has been challenged by emerging Asian economies (Okamoto, 2014). This stagnation can be attributed to various factors, including:

a) Demographic changes and workforce aging

Japan's ongoing warning about the population rapidly aging, with the proportion of people aged 65 years and older projected to increase from 28% to 38% by 2050 (Zhao, 2023). This aging population negatively affects Japan's economic growth, as observed through a decrease in the replacement ratio of pension, stable productivity with an increase in retirement age, and a decrease in overall cumulative savings (Kamio & Espinoza, 2023). This structural issue causes a shortage of skilled labor, limiting productivity gains, and puts the country in a state of chronic lack of domestic demand (Horiuchi & Otaki, 2017)

However, policies that remove obstacles hindering labor supply and enhance a more efficient allocation of workers of all age groups can mitigate the effects of demographic aging on the macroeconomy and reduce fiscal pressure (International Monetary Fund, 2009). The long-run analysis also shows that demographic changes have statistically significant effects on macroeconomic variables, including domestic savings, domestic investment, real GDP, inflation, fiscal balance, and current account balance (Kitao & Mikoshiba, 2020).

b) Japan's Managerial strategies failure

As Japan struggles in terms of innovation for almost 30 years, combating to keep its position as The Country of The Future, conversely to other East Asian countries that seem to manage to grow despite the challenges. The country has developed strategies to address this by focusing on institutional infrastructure, including government agencies, official plans, and programs, to support and fund research activities in both the public and private sectors (Shvydko, 2022). However, there is a need for reliable criteria and methods to assess the effectiveness of financial and organizational support for research and innovation (Yamaguchi, 2019).

Professor Yamaguchi's research highlights the innovation crisis in Japan and proposes a new theory of innovation structures, emphasizing the importance of a significant transition in focus for successful innovation (Okamoto, 2014). There is a growing move in the Asia-Pacific region to explore a new growth paradigm centered around innovation, and Japan must determine its strategy to make full use of Asia's vitality while contributing to regional development (Connell et al., 2012). Cooperation between Japan and the United States in fostering innovation and growth is seen as a potential area for deepening economic relations and meeting global challenges (Holroyd & Coates, 2007a). In this work, we try to analyze the situation from different

perspectives, focusing on similarities and differences between Japan and other Asia-Pacific successful countries to provide concrete examples for Japan to exploit. It is also essential to avoid oversimplification of the situation and to recognize that innovation is a complex and context-dependent phenomenon. Japan continues to excel in certain areas of innovation such as advanced robotics, precision manufacturing, and biomedical research. In summary, Japan could learn key lessons from the experiences of China and South Korea to adapt and regain leadership in innovation.

c) Cultural Aspects Impacting Innovation

Japanese culture promotes process innovation and process technology excellence (Herstatt, 2006). However, it does not encourage individuality or risk taking, which are important for inventing (Westlund & Calidoni, 2010). The cultural attributes of collectivism, power, uncertainty avoidance, and Confucianism play a role in shaping Japan's innovative strengths and weaknesses (Herbig & Jacobs, 1998).

Traditional Japanese culture, with its emphasis on group harmony and preferences for established stakeholders, still influences the country's economy and industrial policy (Herbig & Jacobs, 1997). Cultural values foster behaviors such as self-reliance, hard work, and the acceptance of sensual gratification, shaping the course of modern technology in Japan (Saha, 1994). In summary, Japan's culture is both positive and negative for the country's innovation, with strengths in the innovation processes and limitations in inventing and risk-taking.

2.2 Overview of innovation in South Korea, Taiwan, and China

a) South Korea's journey

Korea's early industrialization in the 1950s focused on export-oriented growth. The government insisted on shaping industrial strategies that directed resources towards key sectors (Hart-Landsberg, 1990). The following era witnessed the rise of Chaebols or large family-controlled business groups, such as Samsung and Hyundai. These conglomerates helped shape the technological advancements and economic growth that Korea knows, going from imitation to innovation, to becoming global players in many industries including electronics, automotive manufacturing, and shipbuilding (Heo & Roehrig, 2014).

South Korea was one of the countries that suffered the most from the Asian Financial Crisis of 1997, and with the cooperation of Koreans and the International Monetary Fund, the government could reset the country to undergo another innovation development period (Al-Shamsi, 2022). Korea emerged as a leader in Information and Communication Technologies (ICT) during the 1990s and continues to maintain this position (Larson, 2017). The Korean government played a crucial role in this process by implementing a series of procedures that led to innovation and economic progress, resulting in increased per capita income, urbanization, and market recovery (Nam, 2022).

In the 2010s, The Korean wave focused on the cultural industry called Hallyu, which has become a global phenomenon and contributes to the country's soft powers (Kim, 2013). Furthermore, to foster innovation and diversity sectors, the government introduced the Innovative Platform Programme, covering areas related to Industry 4.0, and aimed to resolve trade-offs between innovation-led growth, income-led growth, and a fair economy (Kim et al., 2019). These efforts have made South Korea the 4th biggest economy in Asia and the 10th largest by nominal gross domestic product (GDP) worldwide (Ghosh & Chanda, 2023).

b) Taiwan innovation development

Taiwan provides a remarkable example of technological development. The territory has shown rapid industrialization, transforming from an agrarian economy to an industrial powerhouse (Fuller, 2020). It focuses mainly on the government, education, and global collaboration.

It began in the 1960s focusing heavily on labor-intensive industries, such as textiles (V. W.-C. Wang, 1995), with the government insisting on implementing export-oriented policies, encourages businesses to produce goods with international standards (Patalinghug, 1992). The government also supported land reforms and equitably distributed agriculture for stable economic planning (Berry, 2011).

In the late 20th century, Taiwan placed a strong focus on education, produced highly educated and skilled workforce (Liu & Armer, 1993), it also founded Science and Technology Parks (STPs) such as Hsinchu Science Park to attract innovation and high-tech industries (Chen et al., 2006). Establishing links between industry and academia, such as National Taiwan University and National Tsing Hua University, helped the most in technological transformation (Mathews & Hu, 2007). Taiwan shifted all the efforts of technological development in the semiconductor industry, with companies such as TSMC leading the way and ICT, including the production of electronic devices, which contributed to its economic success, making it an attractive ground for multinational corporations and an integral part of global supply chains, especially in the electronics industry (Chang & Trappey, 2003). Taiwan's economic growth is strongly supported by innovation and quality, with SMEs leading technological innovations (Hsu et al., 2019).

It demonstrated a remarkable ability to adapt to changing situations and markets, facing economic and geopolitical challenges, showing resilience in navigating these obstacles.

c) China's rise as an innovation powerhouse

In the late 1980s, China started emerging as a major industrial competitor in high-tech and growth sectors, aiming to become a world leader in key industrial sectors through its "Made in China 2025" strategy. The country has focused on strengthening its domestic innovation capacity and reducing its reliance on foreign technologies, with the goal of moving up in global value chains. China's rise as an innovation powerhouse is

evident in its achievements in science and technology, growing exports of high-tech goods, and ranking in innovation indices (Lemutov, 2023). The development of innovation clusters, such as the Belt and Road Initiative (BRI) and the city of Shenzhen, has further contributed to China's technological advancement (Cheng & Trigo, 2022).

China's approach to attaining a dominant position in international markets through industrial, research and innovation, trade, and foreign direct investment policies has positioned it as a major industrial competitor in the rapidly expanding high-tech sectors (European Commission. Joint Research Centre *et al.*, 2019; Preziosi *et al.*, 2019). The government's focus on innovation as a key national strategy for economic growth has led to the development of intellectual property laws and other strategies that encourage technological development and successful innovation (Zhong et al., 2020).

3. COMPARATIVE PERSPECTIVE

3.1 How relevant is it to compare: Japan, South Korea, China, and Taiwan in terms of innovation?

Given the economic dynamics of the East Asian region. Each territory has its own strengths and weaknesses in their technological and innovation approaches. Making it valuable to understand the regional dynamics by studying mainly China as the biggest economy in the region, South Korea showing impressive efforts and advancements in many fields (Shin et al., 2022) that allowed a fast growth in a short time, and Taiwan being complementary to Japanese economy ("China factor will boost Japan-Taiwan economic ties," 2023) in addition to being a key player in the region and worldwide. It is also valuable to compare:

1. Diverse innovation strategies: based on historical, cultural, and economic context, each country developed a unique vision, and comparing these strategies offers insights of the effectiveness of these different approaches.
2. Global economic impact: it goes without saying that East Asia plays a crucial role in the global economy particularly in industries influenced by technology. By 2022, four of the world's five biggest science and technology clusters are located in East Asia: one in Japan, two in China, one in Republic of Korea (*Biggest Global Innovation Index (GII) S&T Clusters*, 2022; *Global Innovation Index's Global Science & Technology Clusters: East Asia Dominates Top Ranking*, 2022).
3. Learning opportunities: By studying the selected nations, rooted in a common culture of harmony and homogeneity (Zhang et al., 2005) it is possible to identify the best practices, challenges, and potential of future collaborations, that could be valuable for policymakers, researchers, and businesses integrated in innovation ecosystems.

3.2 Our definition of innovation in East Asian setting

Before moving to the metrics, and based on the World Intellectual Property Organization (WIPO) Four of the world's five biggest science and technology clusters are in East Asia (WIPO, 2022). Which makes it important to acknowledge the unique characteristics and strengths of the region. To better reflect the technological and economic dynamics of East Asia, we set a definition of Innovation tailored to the region, which may diverge significantly from the conventional Western framework (Hobday, 1996), necessitating a nuanced understanding of the trends of the region.

"In East Asia, innovation is the dynamic organized process driven by a strong pursuit of technological advancement, impacting by consequence economic growth and societal progress. These cultures rooted in harmony and homogeneity integrate cutting-edge advancements while asserting their historical legacies. The East Asian innovation culture places a distinct emphasis on catch-up strategies, adaptive resilience, and continuous learning and improvement.

It is characterized by the focus on emerging technologies in some areas to boost specific industries, driving worldwide various advancements and shaping global trends. Their philosophy includes a testament to a collective commitment to excellence, united vision, and forward-looking innovation practices."

4 JAPAN'S INNOVATION STRATEGY

Japan's innovation strategy focuses on long-term planning, considering the changing global situation and the country's development priorities. The government is actively promoting innovation through measures such as supporting private initiatives, providing tax incentives, and increasing funding for research institutions (Zubkova, 2022). The COVID-19 pandemic has spurred innovation in Japan, leading to the creation of original products and solutions that address the challenges posed by the pandemic (Tikhotskaya, 2022).

Japan aims to build a human-centered society with information technologies through its Society 5.0 innovation policy, but faces challenges in achieving both human-centered design and scalability (Fukami & Masuda, 2022). The country has a complex pattern of innovation programs, with national and local governments implementing initiatives to support technology-based infrastructure and balanced regional development (Edgington, 2016). Japan sees the rise of emerging Asian countries as an opportunity for growth and is exploring strategies to make use of Asia's vitality while contributing to the region's development (Okamoto, 2014).

5. SOUTH KOREA'S INNOVATION APPROACH

South Korea blends traditionalism and innovation in its approach to innovation, with a focus on research investments, modernizing the academic system, and concentrating on key areas where the country can make an impact (J. W. Wang et al., 2023). The country's innovation and development strategies strongly focus on research and development (R&D), industrial design, and intellectual property (IP) protection. R&D and industrial design have been found to positively impact high-technology exports (Al-Shawaf & Yasmin, 2021).

To foster innovation in various sectors, South Korea introduced the Innovative Platform Programme (IPP), which covers areas such as artificial intelligence and blockchain (Kim & Choi, 2019). South Korea's technological progress has been driven by a unique model of technology transfer and development, in which the country relies on its national research system to add innovative content to its imitative products (Al-Shamsi, 2022). Additionally, South Korea focuses on the development of electric vertical takeoff and landing (eVTOL) technology, with a priority on controlling autonomous flight and propulsion (Choi et al., 2022).

6. TAIWAN'S INNOVATION STRATEGIES

Innovation is considered a key factor in Taiwan's economic growth, where the focus is on enhancing industrial technology and stimulating innovation within firms, particularly small and medium-sized enterprises (Pan & Wen, 2022). The government has implemented various policy measures to support innovative investment, such as establishing science-based industrial parks, organizing innovation alliances, expanding research institutes, providing tax incentives, and facilitating access to venture capital (Jiann-Chyuan, 2017).

7. CHINA'S INNOVATION ECOSYSTEM

China's innovation approach involves a historical orientation towards technology, evolving from a fast follower to a true innovator (Rowe & Yannakou, 2023). The country has prioritized becoming self-reliant in Science and Technology, strengthening basic research, achieving breakthroughs in core technologies, and promoting innovation (Gary Wong et al., 2022). Wage-induced innovation and massive investments in industrial sectors have been significant drivers of China's economic growth (Li, 2023).

The country has also established initiatives to build Beijing into an international scientific and technological innovation center (Zhou et al., 2021). To address the challenges of innovation and research, a problem-oriented approach has been proposed that focuses on the main problems and challenges of China's innovation journey (Lean, 2022). Despite historical obstacles, China has demonstrated considerable innovation and development, particularly in light manufacturing and consumer goods industries.

8. KEY SIMILARITIES AND DIFFERENCES

a. Common elements in innovation strategies

South Asian countries of Japan, South Korea, Taiwan, and China share common some common elements in their innovation strategies. They all place Science, Technology, and Innovation (STI) in the center in driving economic development and have implemented planned policies to encourage innovation and technology development (Lee & Su, 2015; Tonatiuh, 2013). They have also focused on building institutional capacity for optimizing governance of STI and integrating the policies into their national development strategies (Brondoni, 2013). In addition, they implemented government-led initiatives to promote innovation and technology development as a means of driving economic growth (Holroyd, 2008; Holroyd & Coates, 2007b; Ruiz, 2013), and focused on collaboration between government, research centers, universities, and companies to foster innovation (Bowonder & Miyake, 1992; Holroyd & Coates, 2007a).

Furthermore, these countries have experienced changes in their industrial organization, transitioning from multinational corporations to global networks that prioritize innovation and creative imitation (Sheng & Gao, 2019). Furthermore, they have developed innovation capabilities in various technological fields, with a particular emphasis on electronic circuits and communication technologies (Ikuo & Kaoru, 2011) .

Japan particularly has emphasized government direction, policies, and programs, as well as direct investment in infrastructure and government-business collaboration. South Korea has also implemented similar strategies, with a strong emphasis on government support and coordination. China, on the other hand, has adapted its national innovation system over the years and has implemented policies to encourage innovation and technology development. These common elements in their innovation strategies suggest potential opportunities for technological cooperation and knowledge exchange among these countries.

b. Distinctive approaches in each nation

While many similarities arise in these countries, their approaches were considerably distinct. China has transitioned from imitation to innovation and has gained recognition for its product innovation capabilities (Jun - Choi, 2023). Japan has realized the need for open innovation and has developed various policies and initiatives to promote collaboration with outside organizations (Kim & Mudambi, 2020). South Korea and Taiwan have focused on the development and production of semiconductors, adapting their industries to global

markets (Tonatiuh, 2013). They also have different corporate structures and strategies, with South Korean firms seeking new advantages in changing markets (Brondoni, 2013), and Taiwan building its innovation capabilities complementary to Japanese knowledge Japanese (Holroyd & Coates, 2007b). These different approaches highlight the importance of linkages and collaboration necessary between these economies to complement each other.

Table 1. Different innovation approaches

Aspect	Japan	South Korea	Taiwan	China
Government support	Strong focus on R&D using 'Open Innovation'	Highest R&D expenditure, decentralization initiatives	Fosters advantageous environment for startups and SMEs	Large state intervention, "Made in China 2025" initiative
Collaboration model	Promotes collaboration between government, industry, academia	Central role of Chaebols (e.g., Samsung, LG)	Enhances innovation within startups and SMEs with support and tax incentives	Integration of international talents and fostering Supply Chain networks
Industrial focus	Diverse industrial sectors with emphasis on technology	Significant focus on electronics, semiconductors	Specialization, particularly in semiconductor manufacturing	Strategic focus on key sectors such as AI, EVs, biotechnology
Role of Conglomerates	Keiretsu system to interlock business and shareholders relationship.	Chaebols as most influential (large family-controlled conglomerates)	Emphasis on SMEs with limited role of large conglomerates	State-owned enterprises and private sector collaboration
Policy Priorities	Focus on technological advancement, innovation, and R&D	Prioritizes R&D investment and strategic planning	Emphasis on niche markets, support for technology startups	Strategic sectors outlined in "Made in China 2025" initiative
Global Positioning	Long history as a technological leader and global innovation hub	Rapid global rise as an innovation powerhouse	Success in electronics, particularly semiconductors	Transition from "world's factory" to global innovation leadership

9. INNOVATION PERFORMANCE METRICS

9.1 Comparative analysis of patent filings

-See table 2 at the end of this document for more details-

9.2 Personalized innovation index

R&D expenditure (Weight: 20%): R&D expenditure as a percentage of GDP.
Patents and trademarks (Weight: 15%): Number of patents granted; Number of trademarks registered.
High-tech exports (Weight: 15%): Share of high-tech exports in total exports.
Innovation index ranking (Weight: 15%): Global Innovation Index or a similar innovation ranking.
Number of research publications (Weight: 10%): Number of research papers published, Citation rates of research papers.
Global competitiveness index (Weight: 10%): Overall ranking on the Global Competitiveness Index.
Startup density (Weight: 10%): Presence of startups with the population.
Ease of doing business (Weight: 5%): Ease of Doing Business Index ranking.

10 SCORING METHODOLOGY

For each metric, we assign a score to each country based on its performance. For example, a higher R&D expenditure as a percentage of GDP would receive a higher score.
We normalize scores if necessary to bring them to a common scale (e.g., 0 to 100).
We multiply each normalized score by the assigned weight for that metric.
We sum up the weighted scores for each country to obtain the overall innovation index score.
After normalizing and applying weights, we calculate the overall scores for each country.

11 JUSTIFICATION FOR THE SHARES

R&D expenditure (Weight: 20%): High R&D expenditure reflects a country's commitment to investing in research and development activities, which is foundational to innovation. Increased spending often correlates with a higher likelihood of generating new ideas, technologies, and products.
Patents and Trademarks (Weight: 15%): The number of patents and trademarks granted indicates the level of innovation output and the protection of intellectual property. A high number suggests a country's ability to innovate and its recognition of the importance of protecting innovative ideas.
High-tech exports (Weight: 15%): The share of high-tech exports in total exports signifies a country's success in producing and commercializing advanced technology products. This metric reflects the competitiveness of a nation in the global market and its ability to capitalize on innovation.
Innovation index ranking (Weight: 15%): Global innovation indices provide a comprehensive and comparative assessment of a country's overall innovation ecosystem. Including this metric allows for a broad perspective on innovation, considering factors not explicitly covered by other metrics.
Number of Research Publications (Weight: 10%): Research publications indicate the quantity and quality of a country's scientific output. A high number of publications, especially those cited by other researchers,

reflects the impact and contribution of a country's research community to global knowledge.

Global competitiveness index (Weight: 10%): A strong correlation exists between a country's innovation capabilities and its overall competitiveness. Including this metric could measure innovation and the efficiency of markets.

Startup density (Weight: 10%): The strength of the innovation ecosystem considers the supporting structures for innovation, including startups. A robust ecosystem that fosters new innovations.

Ease of doing business (Weight: 5%): A favorable business environment can encourage innovation by reducing bureaucratic hurdles and fostering entrepreneurship. Including this metric acknowledges the importance of a conducive business environment in promoting innovation.

12 THE FORMULA OF THE SCORE

Score= (Normalized Metric Value−Minimum Value/ Maximum Value− Minimum Value) × 100

Table 3. Personalized innovation index calculations

Metrics scores	**China**	**South Korea**	**Taiwan**	**Japan**
R&D Expenditure score*	51.2	98.6	79.2	71.8
Patents and Trademarks**	100	14.68	3.58	17.88
High-Tech Exports	27	34.1	36.34	15
Innovation Index Ranking	55.3	57.8	55.3***	53.6
Number of Research Publications	100	8.56	3.60	11.54
Global Competitiveness Index (2023)[1]	84.41	94.80	93.73	75.43
Startup density**** (2023)[2]	Number of startups: 651,574 Score: 4.37	Number of startups: 64,140 Score: 11.71	Number of startups: 7400[3] Score: 2.93	Number of startups: 113,052 Score: 8.67
Ease of Doing Business[4]	82.8	95	80.9[5]	84.1

Notes:

*Highest DGP expenditure on R&D is in 5% range or higher (Dyvik, 2024).

**China accounts the highest number of patents and trademarks in the world.

***Same as China given that it is included in the study with China (*China Innovation index - data, chart*, 2022).

****Highest number of startups in the world in 2023 is in the United States of America with 3,525,421 startups (Enginsoy, 2023).

13 THE WEIGHT ASSIGNMENT

Table 4. Country index

Weight	China	South Korea	Taiwan	Japan
R&D Expenditure score (20%)	10.24	19.72	15.84	14.36
Patents and Trademarks (15%)	15	2.20	0.54	2.68
High-Tech Exports (15%)	4.05	5.12	5.45	2.25
Innovation Index Ranking (15%)	8.30	8.67	8.30	8.04
Number of Research Publications (10%)	10	0.86	0.36	1.15
Global Competitiveness Index (10%)	8.44	9.48	9.37	7.54
Startup density (10%)	0.44	1.17	0.029	0.87
Ease of Doing Business (5%)	4.14	4.75	4.05	4.21
Country index	60.60	51.96	44.19	41.10

14. RESULTS AND DISCUSSIONS

a. R&D expenditure

South Korea has the highest score in R&D expenditure indicating a strong commitment to research and development activities. China and Taiwan also have significant scores in this category, demonstrating substantial investment in innovation.

Cross analyzing R&D expenditure with patents and trademarks, we observe that the high expenditure in South Korea is not translating into patents and trademarks as effectively as in China. This suggests that while the investment of the former in heavy, there might be inefficiencies or delays in patenting processes or commercialization of research.

b. Patents and trademarks

China leads in the number of patents and trademarks, suggesting a robust intellectual property landscape.

South Korea also has a respectable score in this category, emphasizing innovation and creativity.

High numbers of patents and trademarks are an indication of a strong emphasis on protecting intellectual property. This can contribute to attracting foreign investments and fostering a culture of focus on innovation.

c. High-tech exports

Taiwan stands out with the highest score in high-tech exports, and a high Global Competitiveness Index, but China, with slightly lower high-tech exports, leads in global competitiveness.

[1] (Matsuoka, 2023)
[2] (Enginsoy, 2023)
[3] (National Development Council, 2023)
[4] (*Japan's Ease of Doing Business*, 2023)
[5] (*Explore economies*, 2023)

Cross analyzing high-tech exports with competitiveness index, we witness that Taiwan's high-tech export strength contributes to its competitiveness, however, China broader economic and infrastructural factors likely give it an edge in the Global Competitiveness Index.

d. Innovation index ranking

South Korea leads in the innovation index ranking, reflecting its overall innovative capacity. China and Taiwan are close competitors, securing strong positions in the innovation index.

Cross-analyzing the Innovation Index Ranking with the number of research publications, we perceive that the high number of research publications in China indicates strong academic and research capabilities. However, South Korea and Taiwan, with fewer publications still maintain high innovation index rankings, suggesting that they might be more efficient in translating research into practical innovations and marketable technologies.

e. Number of research publications

China dominates in the number of research publications, indicating a significant contribution to global scientific knowledge.

Japan also has a substantial score in this category.

The quantity and quality of research publications tend to reflect the strength of a country's academic and research institutions. Nations with a robust research output often have a solid foundation for innovation which could be the reason that brings them up in the innovation index ranking worldwide.

f. Global competitiveness index

China again leads in the Global Competitiveness Index, showcasing its competitiveness on a global scale.

South Korea and Taiwan demonstrate high competitiveness as well, with Japan slightly falling behind.

g. Ease of doing business

South Korea has the highest score in ease of doing business, reflecting a favorable business environment, but it is outperformed by China in startup density.

Cross-analyzing the Global Competitiveness Index and Ease of Doing Business indicate a favorable and advantageous business environment. This could be attributed to efforts made to increase efficiency in regulatory frameworks, infrastructures, and by consequence a healthy economy. As China outperforms South Korea in this area even though it shows the highest Ease of Doing Business score, the latter might benefit from policies that specifically support startup growth and reduce barriers to entry for new businesses, such as access to funding, mentorship programs, and incubator programs.

h. Startup density

China and Taiwan have high scores in startup density, suggesting a thriving startup ecosystem.

South Korea also has a notable score, indicating a dynamic environment for new businesses.

High startup density shows a dynamic entrepreneurial ecosystem, which is often linked to new innovations. Startups are often the source of new ideas, technologies, and economy revival.

i. Overall country index

China emerges as the leader with the highest country index, indicating a well-rounded performance across all categories.

South Korea and Taiwan follow closely, showcasing their strengths in innovation and competitiveness, and determined to growth.

Even when Japan has strong numbers compared to other countries it has in our comparison a lower overall score, which puts forward areas for improvement in the measured criteria.

In a nutshell, South Korea's high position in the global innovation index is a result of strong R&D spending and a favorable business environment. However, changes to the patent and trademark practices might improve the country's intellectual property environment.

China adopting a balanced strategy leads the world in patents, research publications, and worldwide competitiveness. To maintain its dominance, China could focus on improving startup support and ensuring that research is translated into commercialized innovation effectively.

Taiwan excels in high-tech exports and competitiveness, but to further stimulate innovation, it should enhance its startup density and patenting procedures.

Finally, in order for Japan to improve its performance in terms of innovation, it must address its deficiencies in terms of competitiveness, startup density, and business environment. Revival may be fueled by improving business operations and utilizing its robust research output.

15. CONCLUSION - RECOMMENDATIONS FOR INNOVATION REVIVAL

To address the pressing need for revitalization of innovation in Japan, a multifaceted strategy is essential. This strategy should prioritize a renewed emphasis on Research and Development (R&D) expenditure, allocating resources across various sectors with flexibility. It is also critical to enhance international collaborations in R&D. By analyzing and integrating successful innovation strategies from neighboring countries, such as South Korea's industrial strategies and focus, and Taiwan's economic complementarity, Japan can gain valuable insights. Similarly, creating cross-disciplinary innovation hubs with convergence of different perspectives from art, humanities, science, and engineering is likely to facilitate holistic innovative ideas that address diverse needs.

Education is a key focus area, with a particular emphasis on elevating the quality of Science, Technology, Engineering, and Mathematics (STEM) subjects. Implementing vocational training programs and lifelong learning initiatives will ensure a skilled and adaptable workforce.

Comprehensive business reforms are imperative. Regulatory adjustments should be made to create a more business-friendly environment for international

companies. Simplifying processes, reducing bureaucratic barriers, and facilitating smoother operations may attract foreign businesses. In this context, a strategic focus on high-tech exports is crucial. While Japan excels in process innovation, balancing it with product innovation is necessary. Encouraging more radical and disruptive innovations can rejuvenate Japan's innovation landscape. Enhanced support for startups, through access to funding, mentorship programs, and incubation centers, will foster a vibrant entrepreneurial ecosystem. One example is to promote innovation tourism by the creation of programs that attract innovators and experts from all over the world to introduce fresh ideas into Japanese ecosystems.

Finally, encouraging a shift towards a more daring and open innovation approach is vital. Moving away from incremental innovations and embracing a culture that values risk-taking, creativity, and individual entrepreneurship is key. Celebrating success stories and viewing failure as a natural part of the innovation process is essential for long-term growth and development.

Table 2. Comparative analysis of patent filings

Innovation Performance Metrics	R&D Expenditure	Number of Patents	High-Tech Exports	Innovation Index	Number of Research Publications
China	China's National Bureau of Statistics released that in 2022 R&D expenditure estimated at US$456 billion 2.56% of GDP (*China's spending on R&D hits 3 trln yuan in 2022*, 2023).	China accounted for 46.8% of the world total. With 1,619,268 patents filed (*Interactive charts: Intellectual property facts and figures*, 2023).	In 2022, Chinese high-tech exports were $ 954.78 Billion, 27% of its exports for the year (TRADING ECONOMICS, 2023a).	According to Cornell University, INSEAD, and the WIPO in 2022 the index reached 55.3 points (*China Innovation index - data, chart*, 2022).	In 2022, China is listed as the biggest publisher of articles with 898,949 articles (Schneider et al., 2023).
South Korea	In 2022 it reached 4.93% from GDP or 110 148 million USD ("Gross domestic spending on R&D," 2023).	In 2022, 237,633 patents filed or 6.9% worldwide (*Interactive charts: Intellectual property facts and figures*, 2023).	Exports of South Korea's high-tech goods amounted to $ 233 Billion, 34.1% of the country's exports (Ministry of Trade et al., 2023).	The index reached 57.8 points (*South Korea Innovation index - data, chart*, 2022).	In 2022, Republic of Korea participated with 76,936 research publications. (Schneider et al., 2023)
Taiwan	In 2022, The NSTC statistics indicated that R&D spending was NT$898 billion (US$28.5 billion) or 3.96% of The GDP (*Policy Guidelines set out by Premier Chen,*	In 2022, 58,000 patents were granted in Taiwan (*Taiwan: patent grant number* 2022, 2023)	Accounted for $ 174.3 billion 36.34 % of total exports in 2022 (Ministry of Economic Affairs, R. O. C, 2023)	*Included in China*	In 2022, Taiwan participated with 32,349 publications (Schneider et al., 2023)
Japan	Japan's total R&D expenditure in 2022 is 3.59% (Statistics Bureau 2023).	There were 289,530 applications for patents in 2022, 8.4% of the world total (Japan Patent Office, 2023).	High-technology exports in Japan were at $ 113.34 Billion. Accounting 15% of its exports. (TRADING ECONOMICS, 2023b)	The index reached 53.6 points (*Japan Innovation index - data, chart*, 2022).	In 2022, Japan participated with 103,723 articles published (Schneider et al., 2023).

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