Lee Kuan Yew School of Public Policy
ASIA COMPETITIVENESS INSTITUTE

ACI Research Paper #04-2023

A Comparative Analysis of Innovation Policies and Performances Between Singapore and Hong Kong

Litianqi FAN

Xuyao ZHANG

May 2023

Please cite this article as:

Fan, Litianqi and Xuyao Zhang, "A Comparative Analysis of Innovation Policies and Performances Between Singapore and Hong Kong", Research Paper #04-2023, *Asia Competitiveness Institute Research Paper Series (May 2023)*

A Comparative Analysis of Innovation Policies and Performances Between Singapore and Hong Kong *

Litianqi Fan and Xuyao Zhang†

May 2023

Abstract: Innovation plays a crucial role in pursuing long-term economic prosperity. This paper analyses the policies of Singapore and Hong Kong conducive to innovation development and uses specific indicators to illustrate their diverse performances. We find that both cities demonstrate comparable levels of education quality, trade openness and foreign direct investment (FDI) attractiveness. While Hong Kong surpasses Singapore in government education expenditure, the latter excels in several other indicators, including tertiary education attainment, R&D personnel, patent quantity and patent revenue. Leveraging on respective strengths and addressing identified weaknesses will be instrumental in narrowing the gap and propelling Singapore and Hong Kong toward global leadership in innovation.

Keywords: Innovation, Patent, Human Capital, R&D, Economic Connectivity, Singapore, Hong Kong

JEL Classification: C43, O32, O57

* We thank Professor Paul Cheung and our colleagues for their comments and helpful advice on this research project.
† Asia Competitiveness Institute, Lee Kuan Yew School of Public Policy, National University of Singapore. 18 Evans Road, Singapore 259364. Email: tiana.07@nus.edu.sg (Fan); sppzhx@nus.edu.sg (Zhang).

1. Introduction

The pivotal role of innovation in promoting economic growth is extensively discussed. Cities, in particular, serve as the core engine behind a nation's progress, leveraging their ability to implement effective strategies, policies, and initiatives that propel innovation (Marceau, 2008).

In Asia, several cities are at the forefront of the innovation race, with specific attention given to Hong Kong and Singapore: Both cities share a similar trajectory of economic success, as depicted in Figure 1, and exhibit common attributes such as limited land area, population size, and natural resources (Wang, 2018). Additionally, Hong Kong and Singapore have been influenced by their historical ties to British colonialism and have undergone a transition from labour-intensive industrial structures to a focus on high-tech industries (Young, 1992). Most importantly, both cities have outlined their blueprint to become global hubs for innovation and technology.

Singapore took its initial steps towards innovation development with the Science & Technology Plan for 1991-1995. Over the years, the city-state's commitment to innovation has been evident in various areas, including substantial investment in R&D and the provision of abundant educational resources. Around the same time, Hong Kong also embarked on its innovation and technological advancement. The establishment of the Applied Science and Technology Research Institute (ASTRI) in 2000 marked a significant milestone. In 2017, President Xi Jinping emphasised Hong Kong's strategic position as an I&T hub in the Framework Agreement on Deepening Guangdong-Hong Kong-Macao Cooperation in the Development of the Greater Bay Area. The aim was further solidified by the Outline Development Plan for the Guangdong-Hong Kong-Macao Greater Bay Area in 2019.

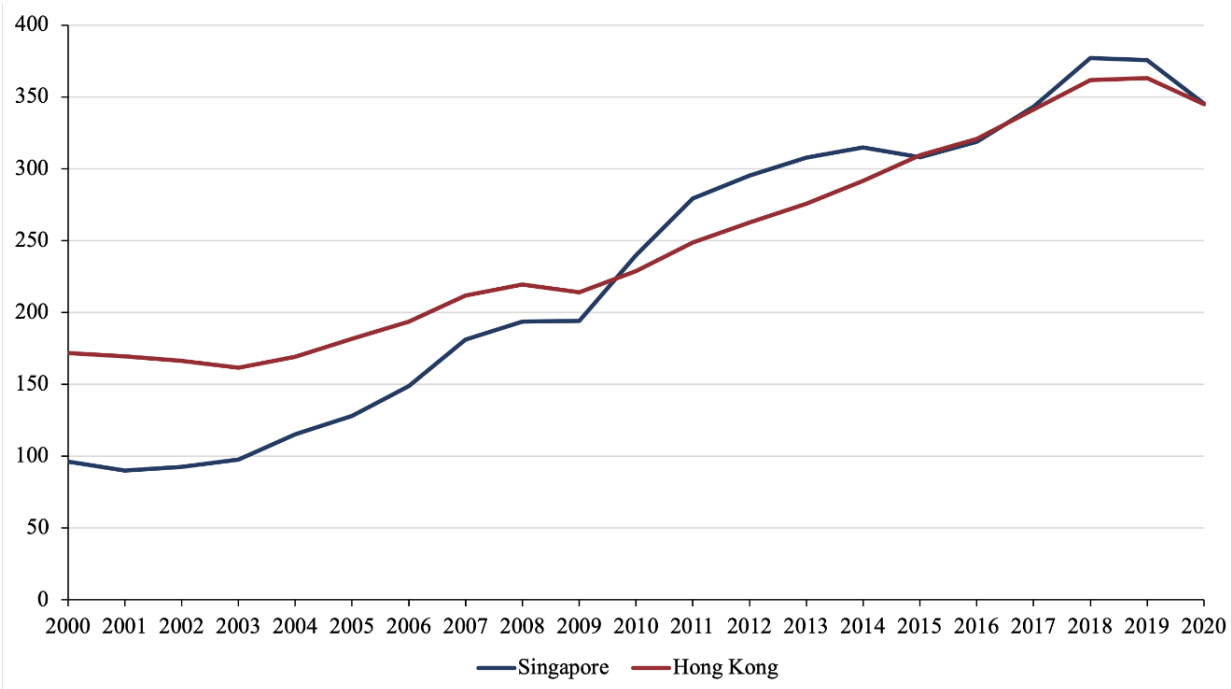
Despite their shared starting points and common aspirations, our study reveals divergent contemporary innovation performances between the two cities. We initiate our analysis with a policy examination focusing on three key dimensions - human capital, R&D, and economic connectivity - in each city. Our findings indicate that Singapore's R&D strategy is predominantly led by the government, with a specific emphasis on developing the Biomedical Sciences industry. Singapore's attractiveness to foreign investment and trade fosters knowledge and technology transfers, with multinational companies (MNCs) contributing significantly to its innovation landscape. On the other hand, Hong Kong's efforts to boost R&D expenditure have yet to yield substantial results. To attract R&D talent, one of the focuses in Hong Kong's policy is to grasp its

close collaborations with the Greater Bay Area. Furthermore, Hong Kong's emphasis on education is evident in various types of scholarships and funding schemes.

In the next step, we evaluate the innovation performances of the two cities, examining specific indicators to identify their relative strengths and weaknesses. We find that Hong Kong's education quality, trade openness, and attractiveness to foreign investment have been neck and neck with Singapore. Notably, Hong Kong exhibits higher dedication to education investment by its government. However, Singapore has been taking the lead in other critical areas, mostly in R&D, encompassing the nurturing of R&D talent, quantity and quality of patents, and tertiary education attainment rate. This comparative analysis provides insights for policymakers in Singapore and Hong Kong, shedding light on future directions and informing innovative strategies for both cities in boosting their innovation potential.

The rest of the paper is structured as follows. Section 2 summarises the major innovation policies of Singapore and Hong Kong and some of their achievements. Section 3 focuses on the comparisons between the two cities' innovation performances. Section 4 concludes by offering policy suggestions based on the findings and analysis presented.

Figure 1: GDP (Current US$ Billion)



Source: ACI based on the World Bank

2. Innovation Policies of Singapore and Hong Kong

In this section, we draw upon previous literature to focus on three key dimensions of policy - R&D, human capital, and economic connectivity - to gain a comprehensive understanding of the innovation strategies in Singapore and Hong Kong.

R&D activities lie at the heart of promoting innovation within cities, as they are the main driving force of innovative outputs such as patents, trademarks, and industrial designs. Indicators such as the number of researchers, R&D expenditure, patents output, and scientific publications have been widely employed in previous research to analyse innovation performance (Hu & Mathews, 2005; Bilbao-Osorio & Rodríguez-Pose, 2004; Furman, Porter, & Stern, 2002; Rosenburg & Nelson, 1994; Furman & Hayes, 2004; Mairesse & Mohnen, 2004). Consequently, human capital is another crucial factor that cannot be overlooked, as it serves as the foundation for innovation and a knowledge-based economy (Zhu, Mao & Zhang, 2020). Policies that enhance human capital could improve innovation through channels such as increasing labour productivity and fostering technological advancements (Cinnirella & Streb, 2017; Diebolt & Hippe, 2018; Sun, Li, & Ghosal, 2020). Furthermore, our analysis advocates for the inclusion of economic connectivity. Economic connections, encompassing trade and investment, provide access to advanced knowledge, technology and larger markets that could benefit innovation output (Schneider, 2005; Cai, Li, & Santacreu, 2022; Girma, Gong, & Görg, 2008; Coelli, Moxnes, & Ulltveit-Moe, 2022). Given the shared challenge of limited land resources in Singapore and Hong Kong, we believe this aspect holds particular relevance to enhancing their innovation performance.

2.1 Singapore

2.1.1 R&D

Starting with Singapore's evolution as a hub for research and development, the focus of its relevant policies can be marked into a few phases.

Following its independence in 1965, Singapore underwent a process of industrialisation that was primarily labour-intensive. However, the country recognised the need to shift towards higher-value goods and began to phase out these industries over the following decades. Therefore, a high priority in policymaking was given to attracting capital- and skills-intensive foreign direct investment during the 1980s and 1990s. In the late 1990s, the government realised the limitations

of relying solely on foreign capital and pursued a more balanced approach that emphasised developing domestic innovation capabilities. This shift included attaching significant importance to the Biomedical Sciences industry as one of the critical pillars of R&D advancement.

Specific plans and initiatives were implemented accompanying this evolving process. Since 1991, the government has carried out seven Five-Year national plans to map its innovation development goals (Table 1). Moreover, the establishment of the Research, Innovation and Enterprise Council (RIEC) and National Research Foundation (NRF) in 2006 marks a significant milestone in Singapore's innovation strategy. The allocated R&D funding in the following Science and Technology Plan was boosted to $13.5 billion, more than double compared to the Plan in 2005. In the latest Research, Innovation and Enterprise 2025 plan, the government distributed $25 billion in stimulating R&D activities, more than 12 times the investment 20 years ago.

The emergence of the Biomedical Sciences industry was a specific focus of Singapore's strategy. The Biomedical Sciences Initiative was first launched in June 2000 to facilitate the aim towards a global biomedical sciences hub. In 2003, Biopolis, positioned as a vital biomedical R&D centre aggregating prominent research institutes and R&D laboratories of numerous pharmaceutical and biotechnology companies, was brought into construction (Beh, 2005). Biopolis has hereafter experienced five phases of expansion to aggregate more private research institutes and laboratories. In 2019, a Phase 6 construction was announced by the Senior Minister of State for Trade and Industry to support more biotechnology companies in embryos to allow an inclusive ambience of biomedical innovation.

To ensure the biomedical manufacturing follow-up, Singapore has simultaneously launched Tuas Biomedical Park, considered a complementary partner of Biopolis, and MedTech Hub in Tukang Innovation Park, mainly aimed at medical device manufacture. In 2020, the biomedical sciences' manufacturing output exceeded 30 billion, contributing 7% to the total GDP.

The substantial growth of the Biomedical Sciences industry in Singapore can be observed from its fast-growing share in the total Gross Expenditure on R&D (GERD). As shown in Figure 3, the Biomedical Sciences industry merely contributed 4.8% of Singapore's total R&D expenditure in 2000, while the proportion surged to approximately 20% in 2019. Alongside Biomedical Sciences, the Engineering & Technology and Natural Sciences sectors are two other significant contributors to Singapore's R&D activities. Furthermore, according to the Singapore

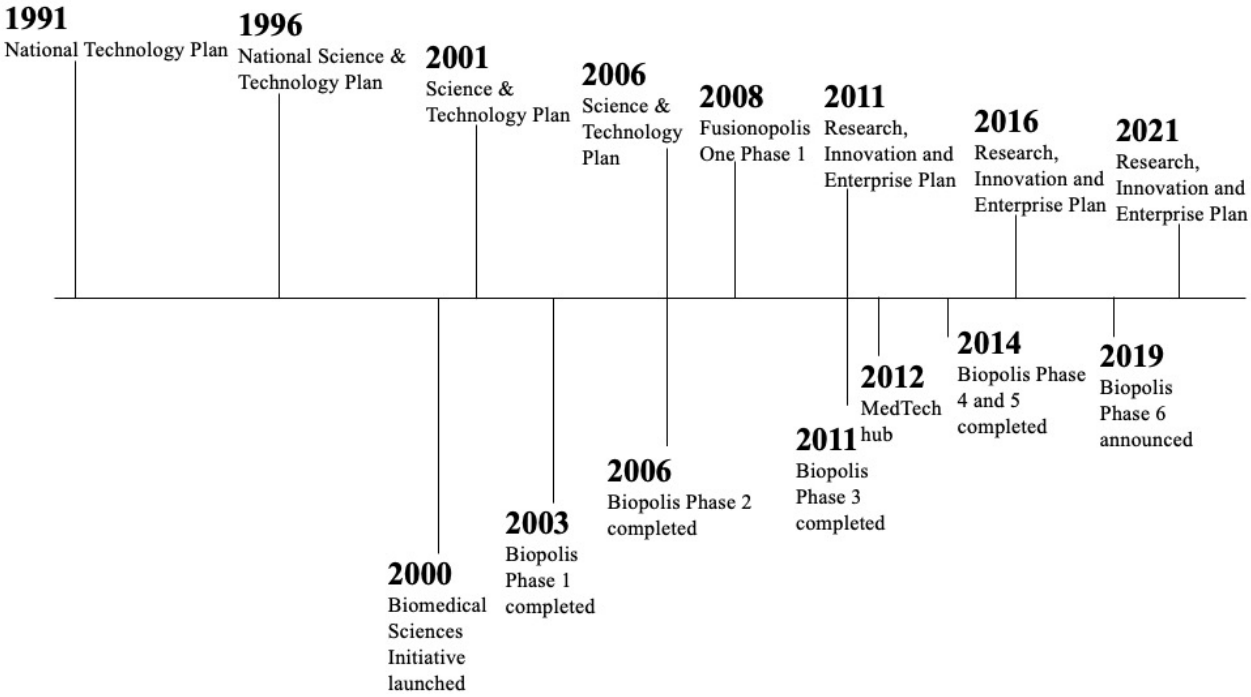
Economic Development Board (EDB), the biopharmaceutical sector has witnessed a remarkable increase in the number of skilled workers, more than doubling since the early 2000s.[1]

Table 1: Government Planned R&D Investment From 1991 to 2021

Plan	National Technology Plan (1991 - 1995)	National Science & Technology 2000 Plan (1996 - 2000)	Science & Technology 2005 Plan (2001 – 2005)	Science & Technology 2010 Plan (2006 – 2010)	Research, Innovation and Enterprise 2015 Plan (2011 – 2015)	Research, Innovation and Enterprise 2020 Plan (2016 – 2020)	Research, Innovation and Enterprise 2025 Plan (2021 – 2025)
Budget	$2 billion	$4 billion	$6 billion	$13.5 billion	$16 billion	$19 billion	$25 billion

Source: ACI based on the Singapore Ministry of Trade and Industry (MTI)

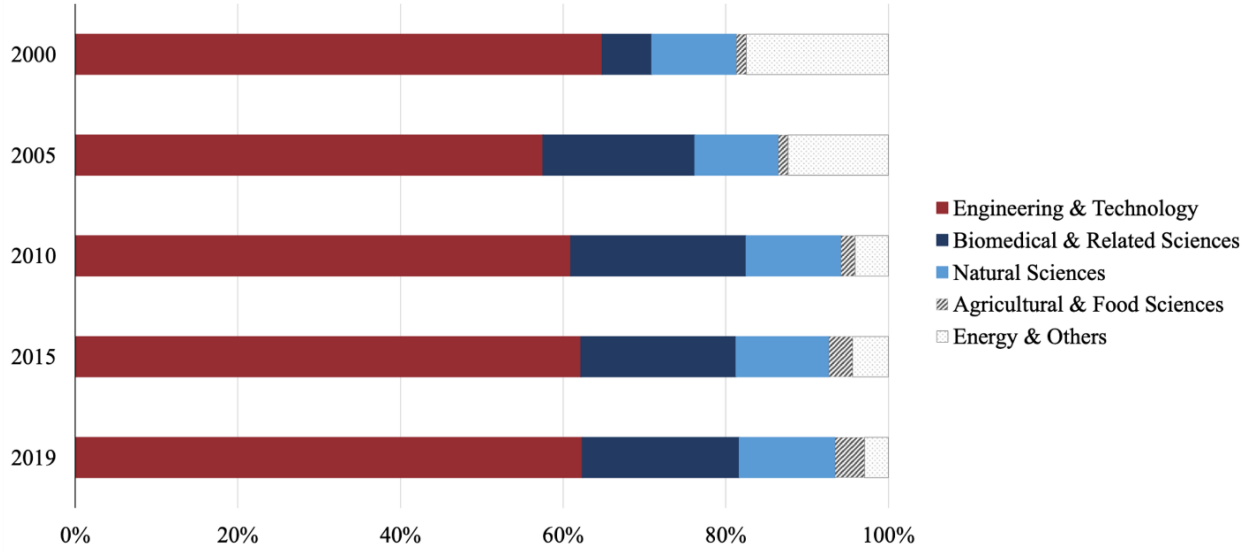
Figure 2: Singapore's R&D and Biomedical Sciences Main Events



Source: ACI

[1] https://www.edb.gov.sg/en/our-industries/pharmaceuticals-and-biotechnology.html

Figure 3: R&D Expenditure by Area of Research



Source: ACI based on the Singapore Department of Statistics (DOS)

2.1.2 Human Capital

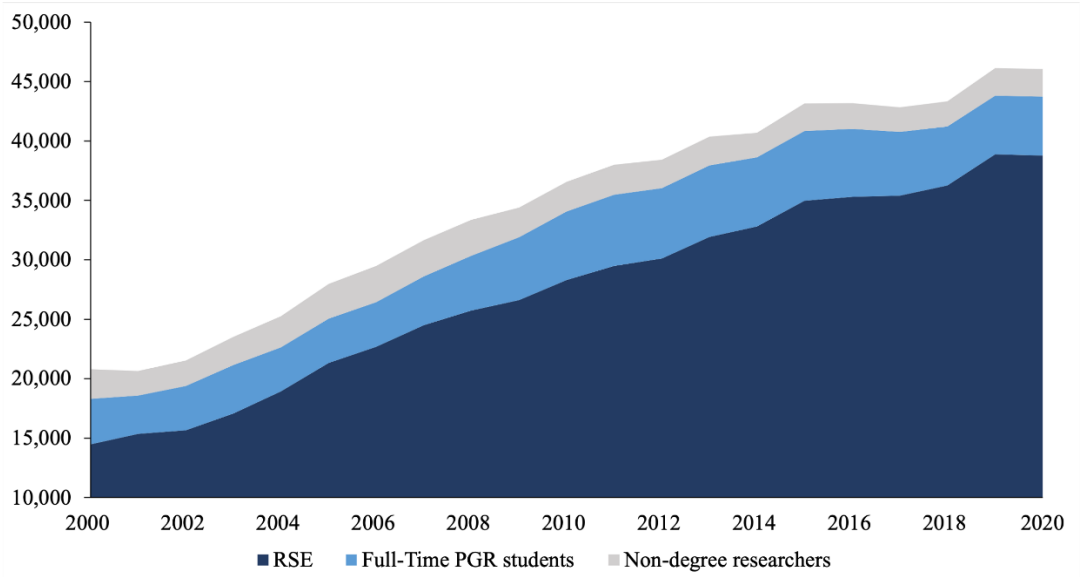
Singapore has made remarkable advancements in human capital and education alongside active research and development (R&D) involvement.

In addition to ensuring a solid foundation of education for its residents through the Compulsory Education Act 2000, Singapore has implemented various measures to promote higher education. A key initiative in this regard is the establishment of the Agency for Science, Technology and Research (A*STAR) in 1991, which offers substantial funding for research and aims to attract top scientists and scientific companies. In particular, A*STAR focuses its funding on four technology domains: Computer and Information Sciences, Biomedical Sciences, Physical Sciences, and Engineering. Moreover, scholarships such as the ASEAN Scholarship and Science & Technology (S&T) Scholarship have been introduced to attract talented international students. Furthermore, in certain postgraduate research programmes at prestigious institutions like the National University of Singapore (NUS), Nanyang Technological University (NTU), and Singapore Management University (SMU), international students and scholars who have received subsidies during their studies are required to fulfil Service Obligations for a specified number of years upon graduation.[2] These measures greatly contribute to Singapore's research capabilities and significantly expand its talent pool.

[2] https://tgonline.moe.gov.sg/docs/A-SO-Eligibility.pdf

As of 2020, A*STAR reported that more than 600 scholars were pursuing or had completed their PhD or post-doctoral education at the institute, publishing 10,856 high-impact publications within that year. Singapore's overall R&D workforce, consisting mainly of research scientists and engineers (RSE), full-time postgraduate research (PGR) students, and non-degree researchers, has displayed consistent and rapid growth over time (Figure 4), highlighting the city-state's capacity and potential for innovation.

Figure 4: The Number of R&D Manpower in Singapore



Source: ACI based on the Singapore Department of Statistics (DOS) and the Agency for Science, Technology and Research (A*STAR)

2.1.3 Economic Connectivity

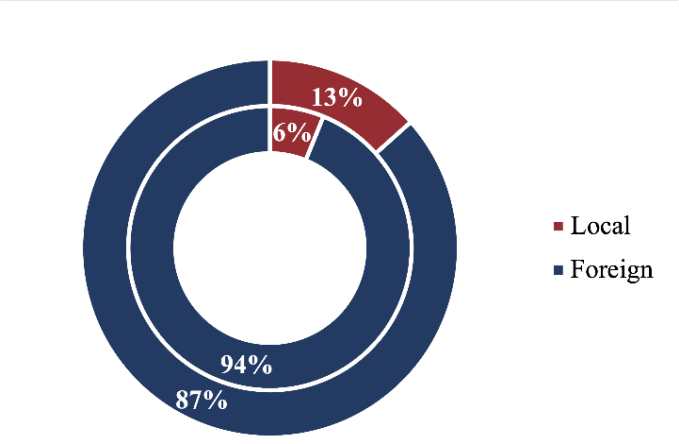
Singapore has implemented measures to strengthen its economic ties with other countries through trade and investment and promote knowledge transfers.

Singapore's relatively low corporate tax rate has been a key factor in attracting foreign investment and fostering a business-friendly environment. It maintains a competitive tax regime with a corporate tax rate of 17%, which is significantly lower compared to many other countries. Singapore's low tax rate, coupled with its efficient tax administration and transparent regulatory framework, not only encourages companies to establish their regional headquarters and operational bases within the country but also serves as an incentive for multinational corporations (MNCs) to conduct research and development activities.

Meanwhile, Singapore has developed an extensive network of 27 Free Trade Agreements (FTAs) to facilitate open markets and free trade. These FTAs provide Singapore-based investors with benefits such as tariff reduction, preferential access to specific sectors, and robust intellectual property protection. In the 2020 Index of Economic Freedom, which measures the level of economic freedom in nations worldwide, Singapore's economy was ranked as the freest in the world by The Wall Street Journal and the Heritage Foundation.[3]

Overall, Singapore's open market and relatively low corporate tax rates have made it an attractive destination for multinational corporations (MNCs). According to the Singapore Economic Development Board (EDB), nearly half of the headquarters based in Asia are located in Singapore. The MNCs have been shown by statistics to significantly contributed to Singapore's innovation ecosystem. In 2020, a majority of patents applied for and registered in Singapore were from foreign applicants, accounting for 87% and 94% of the total, respectively (Figure 5). Notably, seven out of Singapore's top ten patent application filers were multinational corporations from countries such as the US, China, Japan, and Saudi Arabia (IPOS Statistics, 2021).

Figure 5: Patent Applications (External Ring) and Registrations (Internal Ring) by Foreign and Local Applicants in 2020



Source: ACI based on the Intellectual Property Office of Singapore (IPOS)

[3] https://www.heritage.org/index/pdf/2020/book/2020_IndexofEconomicFreedom_Highlights.pdf

2.2 Hong Kong

2.2.1 R&D

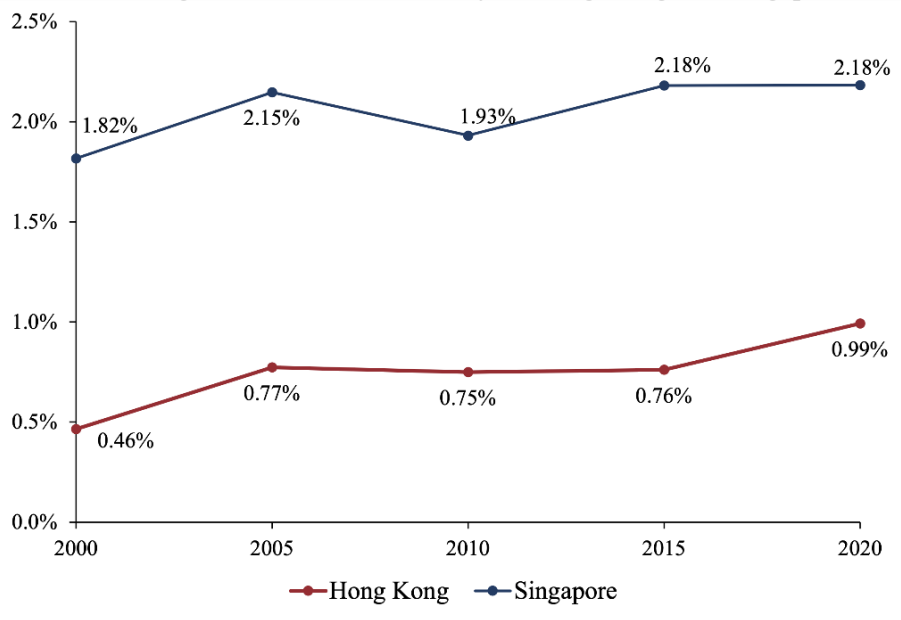
Prior to 1997, Hong Kong pursued a free-market strategy with minimal government intervention, distinguishing itself from Singapore's proactive government leadership (Siu-kai & Hsin-chi, 1990; Goodstadt, 2005). However, following the Handover of Hong Kong in 1997, the local authorities began implementing policies to stimulate R&D expenditure.

In 1999, the Innovation and Technology Fund (ITF) was established to enhance government support for innovation and technological development.[4] Under the ITF, various funding programs were introduced, including the Innovation and Technology Support Program (ITSP), which supports local universities, public research institutes, and R&D centres. In 2010, the ITF launched the Research and Development Cash Rebate Scheme (CRS) to incentivise R&D investment in the private sector and encourage partnerships between local enterprises and public research institutes. Additionally, in 2015, the Enterprise Support Scheme (ESS) was introduced under the ITF to provide financial assistance to private firms engaged in R&D activities. These initiatives have resulted in an increase in R&D expenditure, albeit at a moderate level. Hong Kong's R&D intensity, measured by the proportion of R&D expenditure to its GDP, reached its highest historical level of 0.99% in 2020. However, the city largely lags behind Singapore, which has consistently maintained an R&D intensity level of approximately 2% (Figure 6).

To further stimulate innovation, Hong Kong's authorities introduced an effective tax deduction scheme in 2018 to encourage businesses to invest in R&D and foster a culture of innovation in Hong Kong.[5] This scheme allows for a tax reduction of 300% for the first HK$2 million of qualifying R&D expenditure and 200% for the remaining expenditure, without any cap on the amount of tax deduction. Moreover, the establishment of innovation and technology hubs, such as the Hong Kong Science Park and Cyberport, provides dedicated spaces for startups, entrepreneurs, and established companies to collaborate and develop innovative solutions. These policy efforts demonstrate Hong Kong's dedication to building a vibrant ecosystem that promotes R&D, innovation, and technological advancement. However, the full impact of these initiatives requires time to materialise and yield tangible results.

[4] https://www.itf.gov.hk/l-eng/about.asp
[5] https://www.chamber.org.hk/en/information/the-bulletin_detail.aspx?id=67

Figure 6: The R&D Intensity of Hong Kong and Singapore



Source: ACI based on Hong Kong Annual Digest of Statistics and the Singapore Department of Statistics (DOS)

2.2.2 Human Capital

Similar to Singapore, Hong Kong's government has demonstrated a commitment to investing in education, with education expenditure experiencing rapid growth over time.

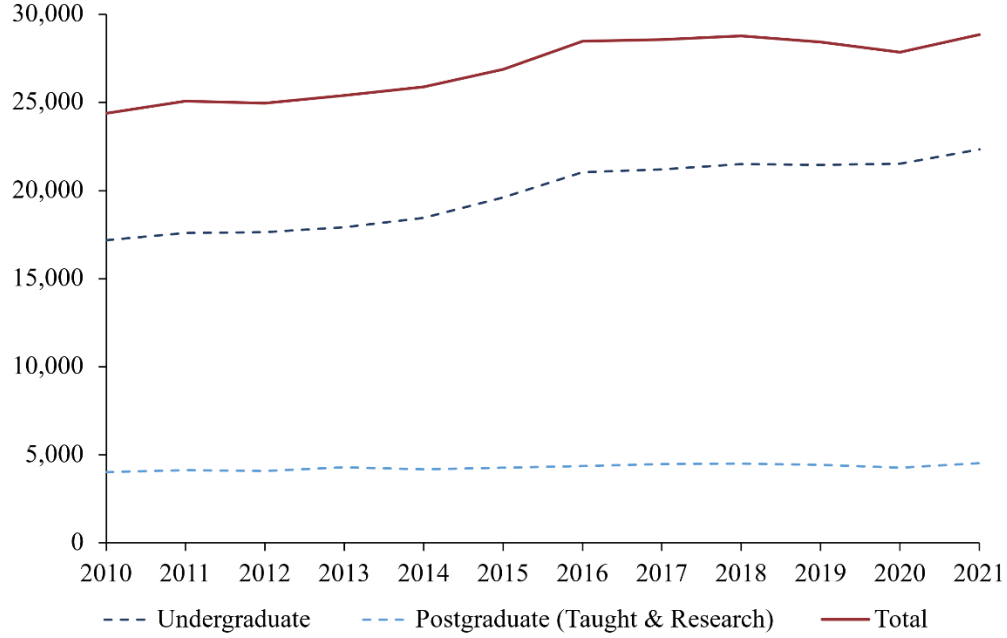
The University Grants Committee (UGC) is pivotal in Hong Kong's education policy. Established in 1965, the UGC serves as a coordinating body for the eight publicly funded universities in Hong Kong, facilitating collaboration and resource allocation among these institutions. Notable universities that receive funding from the UGC include the University of Hong Kong (HKU), the Chinese University of Hong Kong (CUHK), and the Hong Kong University of Science and Technology (HKUST), among others. The Research Endowment Fund (REF) was further established in 2009 to provide a steady flow of research funding for the institutions. As the governing body of the REF, the UGC is entrusted with the task of advising and formulating policies related to the operation, development, and investment of the Fund. This strategic role allows the UGC to actively shape the research landscape in Hong Kong and contribute to advancing knowledge across various academic disciplines.

Apart from the above, the Research Grants Council (RGC) was established in 1991 under the operation of the UGC. One of the most important responsibilities of the RGC is the management of the Hong Kong PhD Fellowship Scheme (HKPFS), which offers generous

financial support for students worldwide to pursue their doctoral degrees at Hong Kong's academic institutions. For the academic years 2023/2024, each HKPFS awardee will receive an annual stipend of HK$325,200 (approximately US$41,690) and a research-related and conference travel allowance of HK$13,600 (approximately US$1,740) for up to three years.[6]

Furthermore, to cultivate human capital in the field of Innovation and Technology (I&T), Hong Kong has implemented targeted policies, such as the STEM Internship Scheme[7] and the Greater Bay Area Youth Employment Scheme[8], to offer proper training and internship for Hong Kong's students. Moreover, the government is actively engaged in collaborations, such as the establishment of the Shenzhen-Hong Kong Innovation and Technology Cooperation Zone, to facilitate the flow of talent between cities in the Greater Bay Area and support young R&D talents in starting their businesses in Hong Kong. Other policy measures, including the Technology Talent Admission Scheme (TechTAS) [9] and a considerable expansion of the Quality Migrant Admission Scheme (QMAS) quota in 2020, were also implemented to enlarge Hong Kong's pool of R&D talent.

Figure 7: Graduates of the University Grants Committee (UGC) Funded Programmes by Level of Study



Source: ACI based on Hong Kong Annual Digest of Statistics

[6] https://cerg1.ugc.edu.hk/hkpfs/enquiry.html#generalinfo
[7] https://www.itf.gov.hk/en/funding-programmes/nurturing-talent/stem-internship-scheme/index.html
[8] https://www.bayarea.gov.hk/en/opportunities/youth.html
[9] https://www.scmp.com/presented/news/hong-kong/topics/technology-talent-admission-scheme/article/3213077/technology-talent-admission-scheme-enhanced-attract-it-talent-around-world-undertake-rd-work-hong

In 2020, the overall expenditure reported in Hong Kong's Annual Digest of Statistics reached HK$108.01 billion, reflecting an annual growth rate of nearly 40%. These figures underscore the government's effort to provide quality education for its citizens. Furthermore, it is noteworthy to highlight the consistent growth in the number of graduates in Hong Kong, showcasing an upward trajectory compared to data from a decade ago (as depicted in Figure 7).

2.2.3 Economic Connectivity

Hong Kong has established itself as a highly sought-after destination for foreign direct investment and international trade, driven by several key factors. One of the primary reasons is its business-friendly tax system, characterised by simplicity and low rates. With a corporate profit tax of around 16.50 per cent, Hong Kong offers one of the lowest tax rates among advanced economies, attracting businesses and encouraging investment (Choi, 2020). This favourable tax environment provides companies with a competitive edge and enhances the overall business climate in the city.

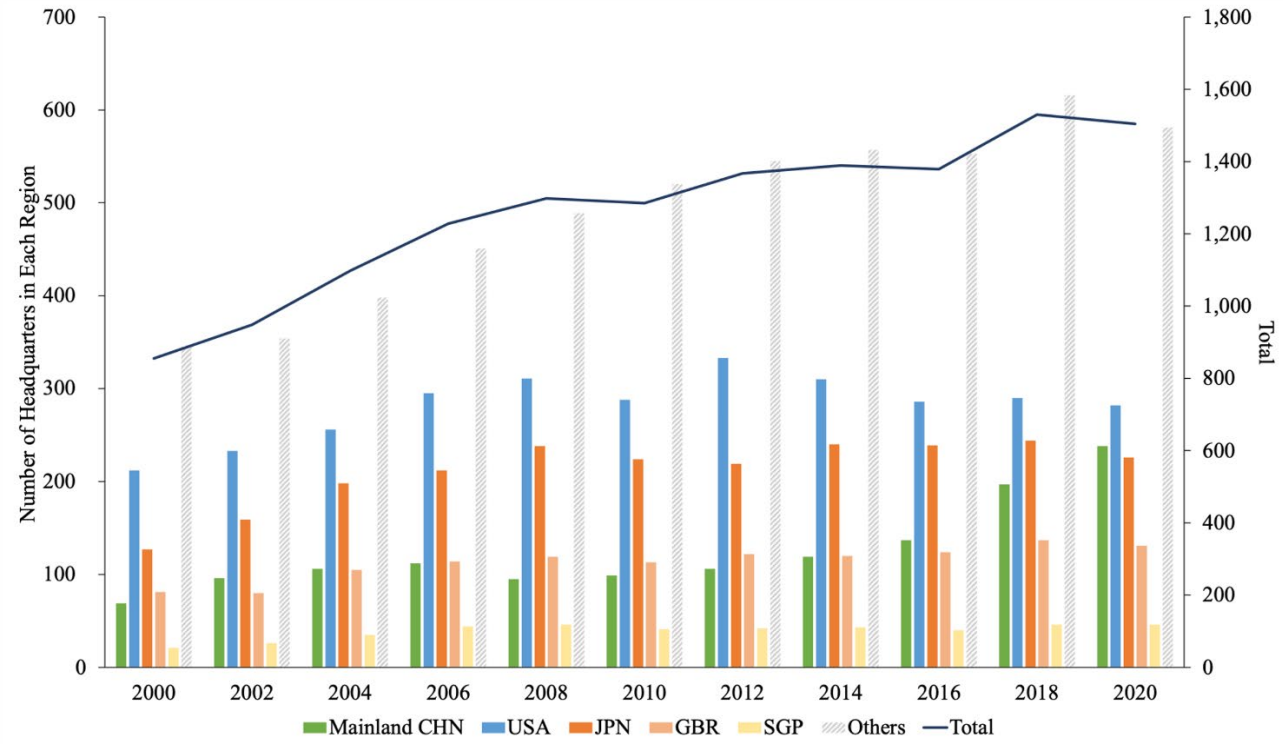
In addition to its tax advantages, Hong Kong has been constantly facilitating free trade. It imposes no custom tariffs on imported or exported goods, making it an attractive trading hub for businesses worldwide.[10] To further promote international trade, the government has established various funding schemes to support small and medium enterprises (SMEs) in developing their global trade activities. Furthermore, Hong Kong actively participates in negotiating and signing free trade agreements (FTAs) to foster an open and conducive trade environment. It has formed FTAs with multiple countries and regions, including New Zealand, the European Free Trade Association (EFTA), Chile, Georgia, and Australia. The recent implementation of the FTA between ASEAN countries and Hong Kong further solidifies its trade partnerships with Southeast Asia.[11]

Moreover, Hong Kong's unique position as a gateway to mainland China has made it an attractive investment platform for foreign enterprises seeking to expand their operations in the region. Over the years, the number of regional headquarters in Hong Kong has steadily increased (Figure 8), reflecting its significance as a stepping stone for international businesses looking to access mainland China's vast market and opportunities. Between 2000 and 2020, the number of

[10] https://www.tid.gov.hk/english/aboutus/tradepolicy/trpolicy.html
[11] https://www.tid.gov.hk/english/ita/fta/index.html

regional headquarters in Hong Kong grew from 786 to 1266, excluding those from mainland China, reflecting its status as a preferred destination for multinational companies.

Figure 8: Number of Regional Headquarters in Hong Kong by Country/Territory of the Parent Company



Source: ACI based on Hong Kong Government Census & Statistics Department

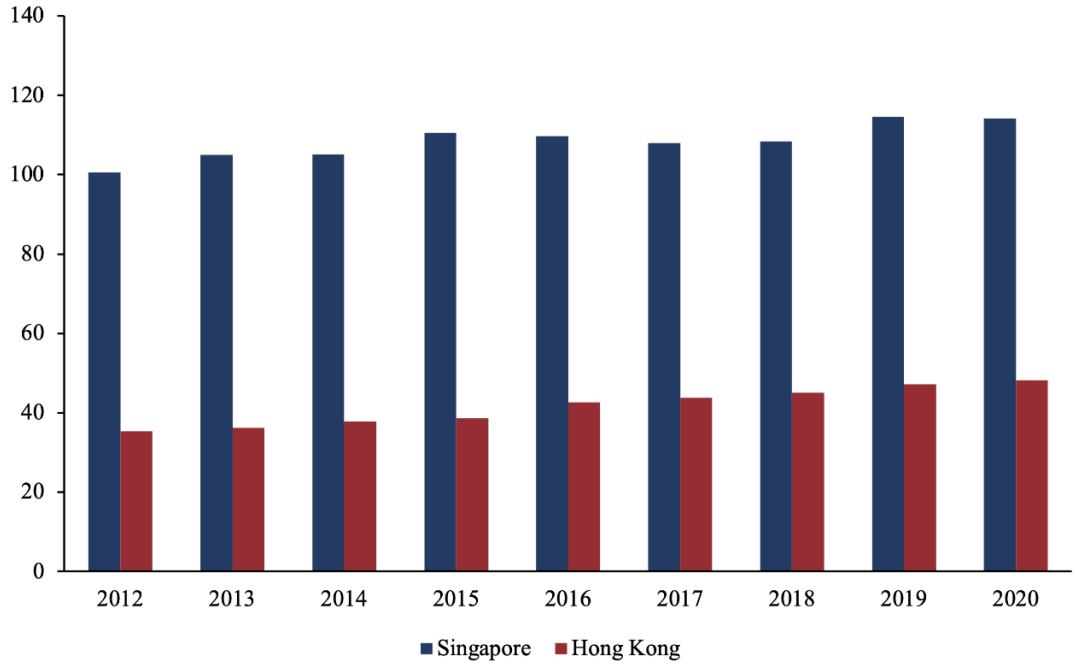
3. Comparison of Innovation Performances

3.1 R&D (R&D Personnel, Patent Output and Revenue)

Acknowledging the crucial role of R&D personnel in developing innovation, we begin by comparing the two cities' number of full-time equivalent (FTE) R&D personnel relative to their population.

In 2012, approximately 100 individuals were engaged in R&D per 10,000 people in Singapore (Figure 9). Over the years, this number has steadily grown, reaching 114 in 2020, with a total R&D personnel (FTE) exceeding 46,000 individuals. In contrast, Hong Kong's R&D workforce, although showing an upward trend, has remained significantly lower than that of Singapore. This disparity underscores Singapore's relative strength in nurturing and attracting R&D talents.

Figure 9: Number of R&D Personnel per 10,000 Persons



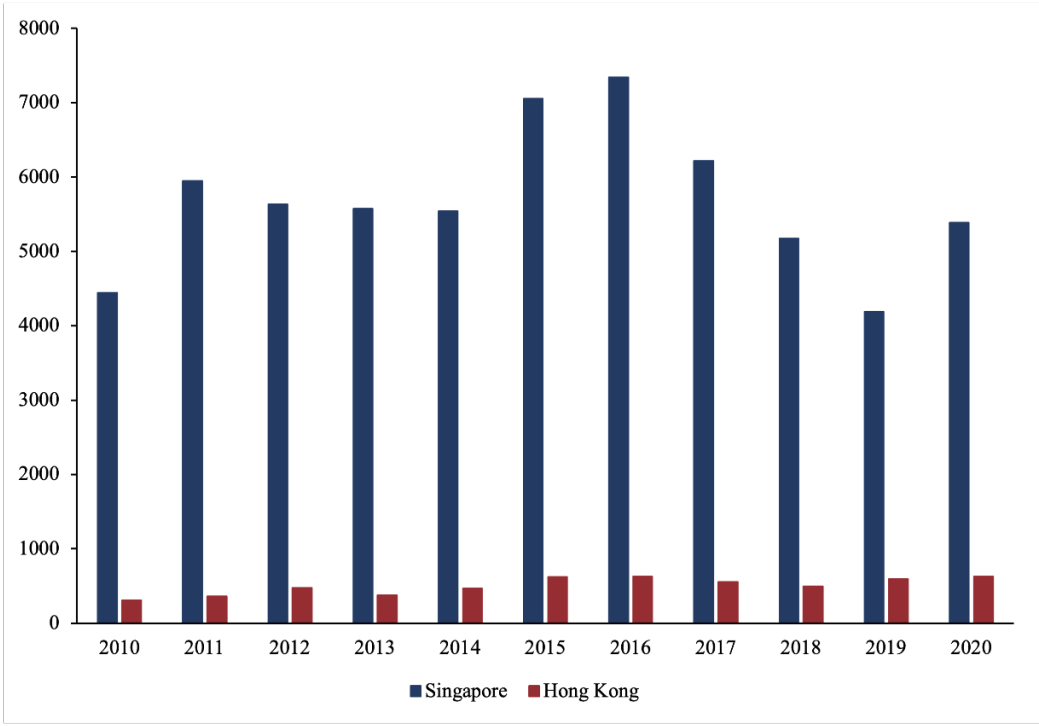
Source: ACI based on the Singapore Department of Statistics (DOS) and Hong Kong Innovation Activities Statistics

Moving forward, we shift our focus to two key indicators associated with patents, which are widely regarded as a crucial measure of innovation output. Given their higher threshold and perceived more excellent value, patents are often considered a valuable indicator of innovation success.

Our findings from Figure 10 and Figure 11 highlight Singapore's leading position in the field of patents. As shown in Figure 10, while Singapore's annual patent output has fluctuated over time, a significant and consistent gap between the two cities is evident.[12] Furthermore, Singapore has experienced exponential growth in revenue generated from transfers and licensing patent ownership (Figure 11). The widening gap, which has expanded from approximately 2.3 billion USD to nearly 8 billion USD, serves as further evidence of Singapore's ability to produce high-quality inventions with a broad international impact.

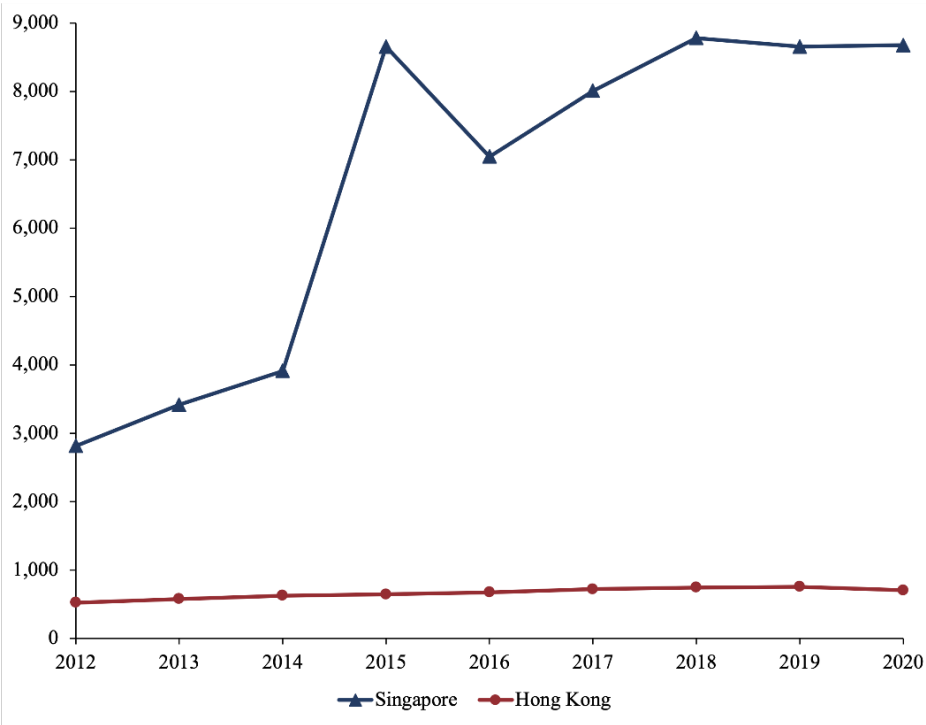
[12] We collect data on the number of granted patents for the two cities from the Intellectual Property Office of Singapore (IPOS) and the China Statistical Yearbook on Science and Technology.

Figure 10: Number of Granted Patents



Source: ACI based on the Intellectual Property Office of Singapore (IPOS) and China Statistical Yearbook on Science and Technology

Figure 11: Revenue From Transferring and Licensing Patent Ownership (Million US$)



Source: ACI based on IndexMundi

3.2 Education (Government Education Expenditure, Tertiary Education Attainment Rate and Education Quality)

As discussed in Section 2, both Singapore and Hong Kong demonstrate a solid commitment to investing in education, with substantial funding and supportive policies in place. By examining their governments' expenditure on education, we observe that Hong Kong's government has consistently exhibited a higher propensity for educational investment on average, as depicted in Figure 12. In particular, Hong Kong's government expenditure on education has exhibited discernible growth trends, both in absolute terms and relative to the total government expenditure. The sudden decrease in 2020 was due to the COVID-19 pandemic when more government resources were allocated to the economic and healthcare areas.

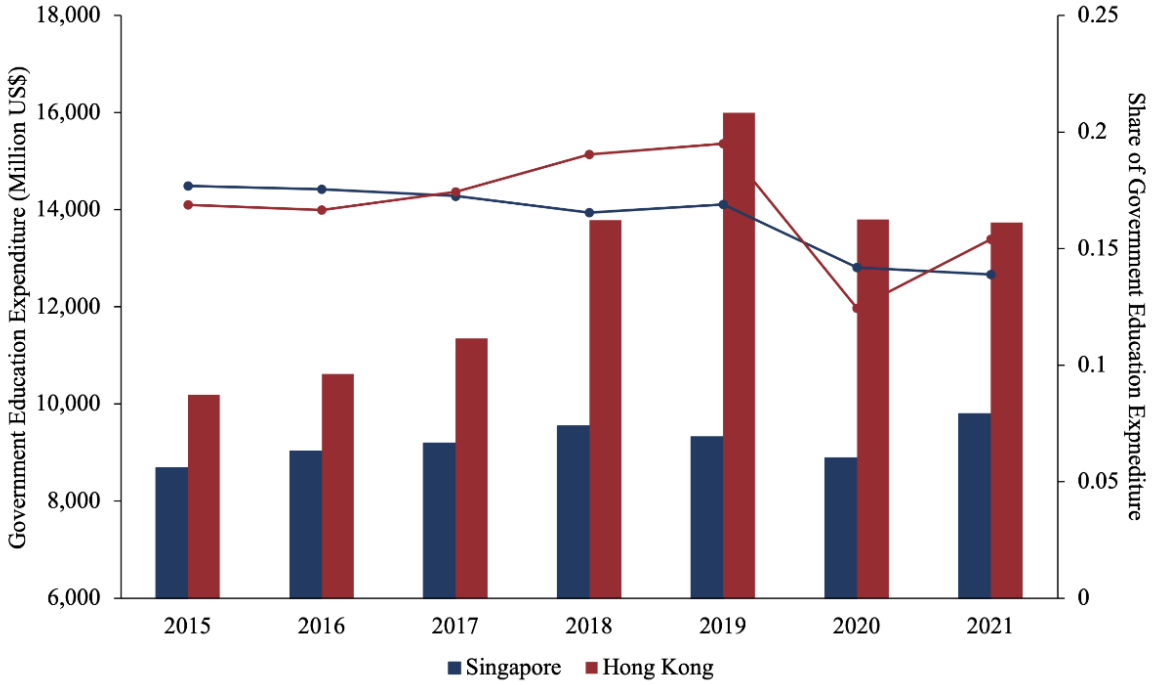
To assess educational outcomes, we analyse the tertiary education attainment rate among the resident population aged 25 and above and evaluate the educational quality of both cities. [13] Figure 13 provides an overview of the trajectories of these indicators for every five years from 2000 to 2020. While both cities have steadily improved their tertiary education attainment rates, Singapore has maintained a faster growth, resulting in a widening gap between the two economies. In 2020, Singapore reached a rate of 48.3%, indicating that nearly half of its resident population aged 25 and above holds at least a post-secondary degree.

Remarkably, various research and statistics show that both cities have achieved world-leading educational quality. Altinok, Angrist, and Patrinos (2018) studied the students' worldwide learning outcomes across subjects (math, reading, science) and education levels (primary and secondary). Their quantitative results indicate that Singaporean students obtained the highest average achievement test scores globally in 2015. Hong Kong, while slightly behind Singapore and South Korea, has also attained outstanding scores in terms of educational quality (Figure 14). The Human Capital Index of the World Bank[14], which ranks both cities among the top performers in developing a skilled labour force, further supports this conclusion (World Bank, 2020).

[13] According to the Human Capital Report of World Economic Forum, tertiary education is defined as an education degree higher than the secondary level.

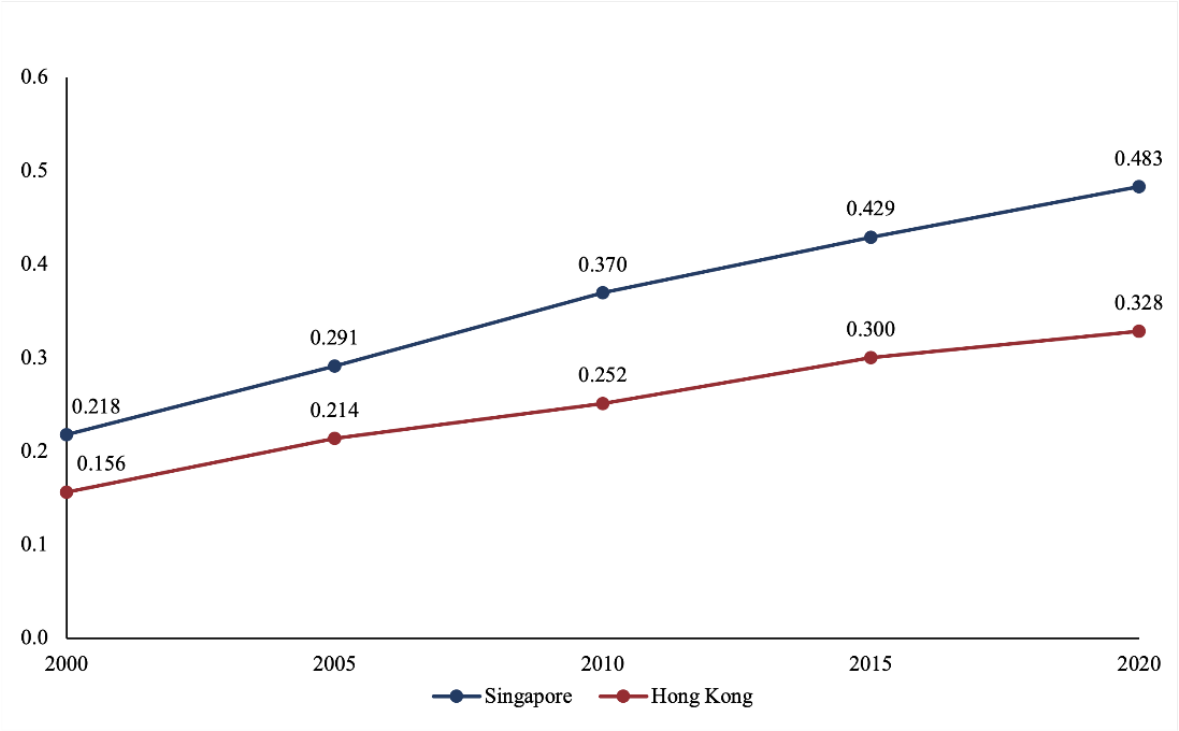
[14] Human Capital Index (HCI) is an index constructed by the World Bank that measures the productivity of the next generation of workers relative to the benchmark of complete education and full health. It ranges from 0 to 1, with a higher value indicates a higher capacity for the economy's children to achive their potential. In 2020, Singapore obtains the highest score of 0.88 out of 1. Hong Kong obtains 0.81, ranking as the second-highest economy out of 173 economies in the world.

Figure 12: Total Amount (Million US$) and Share of Government Expenditure on Education



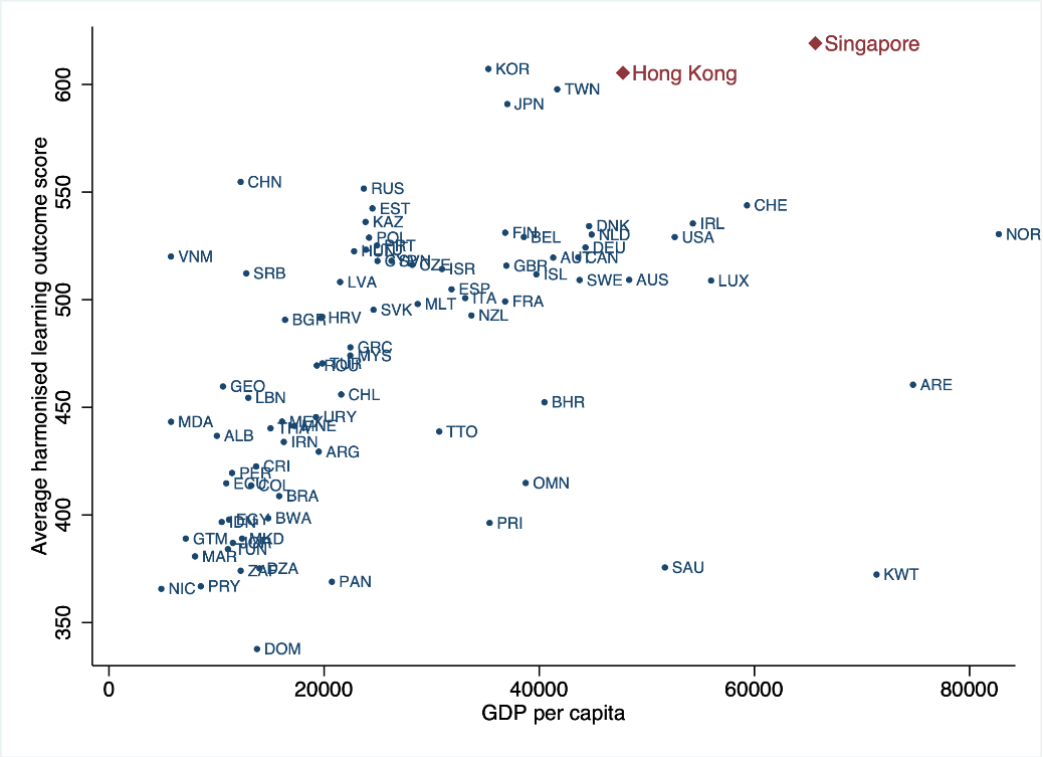
Source: ACI based on the Singapore Department of Statistics (DOS) and Hong Kong Annual Digest of Statistics

Figure 13: Tertiary Education Attainment Rates in Hong Kong and Singapore



Source: ACI based on the Singapore Department of Statistics (DOS) and Hong Kong Population Census

Figure 14: Average Learning Outcomes in 2015



Source: ACI based on Altinok, Angrist and Patrinos (2018)

3.3 Economic Connectivity (Trade Openness and FDI Attractiveness)

As our last comparison, we focus on two key indicators, attractiveness to foreign direct investment and trade openness, in assessing both cities' economic connectivity.[15]

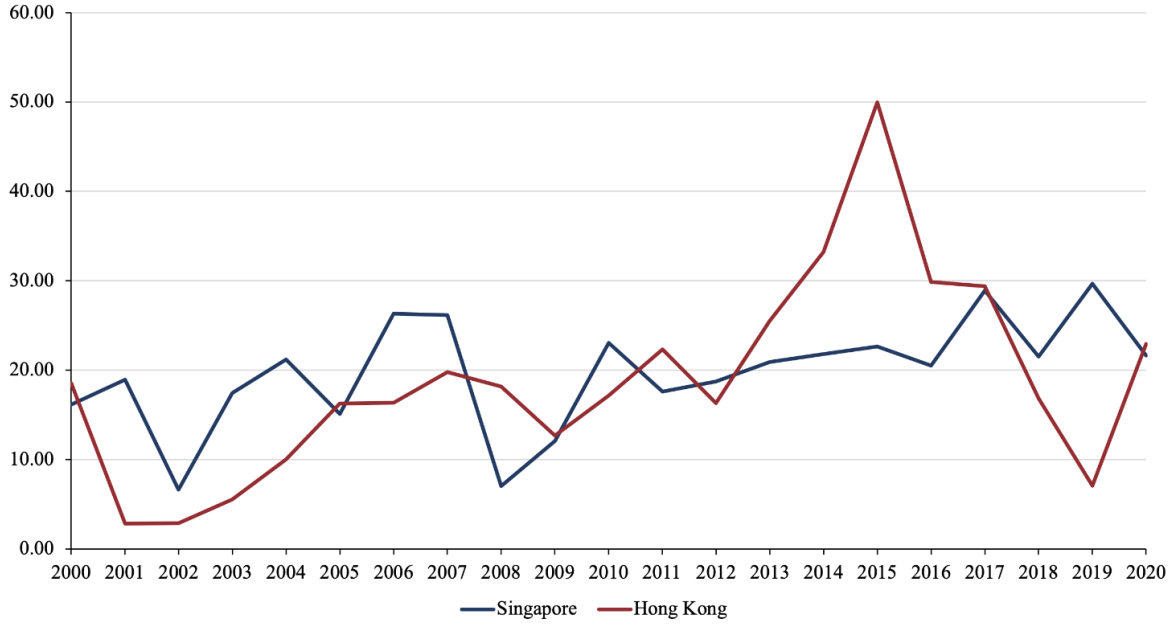
Both Singapore and Hong Kong have offered favourable tax regimes and foraged policies that aim to foster a conducive environment for investment. Looking at Figure 15, while the ratio of FDI net inflows to GDP may exhibit fluctuations over the years, the general trend for both cities has been upward. This sustained level in FDI inflows indicates Singapore's and Hong Kong's attractiveness as investment destinations.

Turning to trade openness, as depicted in Figure 16, the progress in Hong Kong has been relatively more evident overall. Both economies experienced a decline during the Global Financial Crisis, followed by a substantial rebound, with Hong Kong exhibiting a more pronounced recovery in 2010. While Singapore and Hong Kong have maintained similar trends in trade openness in

[15] We compute trade openness by taking the sum of exports and imports for both merchandise and services of each city, and divide it by the respective city's GDP. The attractiveness to foreign direct investment (FDI) is measured by calculating the ratio of FDI net inflows to the respective city's GDP.

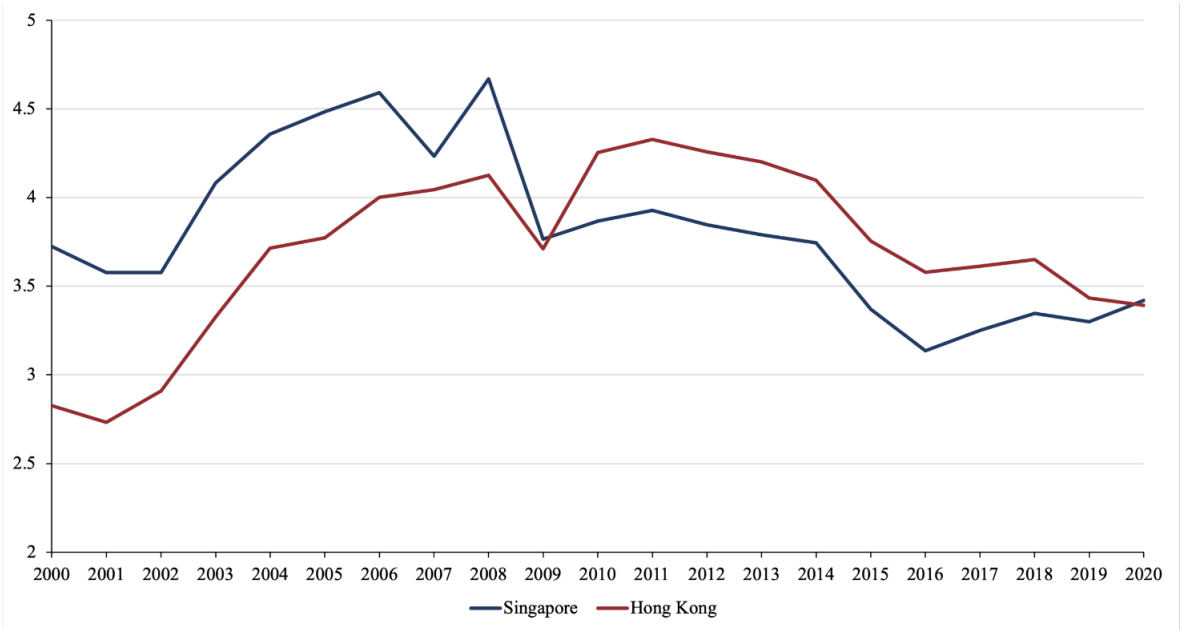
subsequent years, the onset of the COVID-19 pandemic has had varying impacts on their trading volumes: Hong Kong's trading volume experienced a more rapid decline and was surpassed by Singapore in 2020.

Figure 15: FDI Inflows to GDP Ratio



Source: ACI based on the World Bank and Hong Kong Annual Digest of Statistics

Figure 16: Trade Openness



Source: ACI based on the Singapore Department of Statistics (DOS) and Hong Kong Annual Digest of Statistics

4. Conclusion

This research delves into an in-depth analysis of the innovation performance gap between Singapore and Hong Kong, examining various dimensions and indicators to provide a comprehensive understanding of the strengths and weaknesses of each city.

A notable disparity between the two cities is evident in the realm of R&D. Singapore's advantages are dominant in its higher number of granted patents, substantial patent revenue, and well-established pool of R&D personnel. These indicators reflect Singapore's successful efforts in fostering an environment that encourages innovation and attracts top R&D talent. Hong Kong, on the other hand, displays a remarkable commitment by its government to investing in human capital and achieving educational excellence. This serves as a strong foundation for Hong Kong's policymakers to leverage and transform their investments into tangible returns. By implementing more favourable policies and creating an ecosystem that enhances the city's competitiveness and attractiveness to R&D talents, Hong Kong can further bolster its innovation potential and narrow the gap with Singapore. Learning from Singapore's successful strategies in nurturing R&D talent and generating high-quality patents can be a valuable model for Hong Kong to emulate and enhance its own R&D ecosystem.

Furthermore, it is observable that while both cities have fostered environments conducive to trade and FDI attractiveness, the dynamics could be subject to fluctuations and evolving market conditions. Therefore, continuous adaptation and resilience are necessary to navigate the ever-changing global landscape successfully. Efforts to enhance economic connectivity and foster vibrant business ecosystems remain imperative for both Singapore and Hong Kong to maintain their competitive edge and seize new opportunities.

In conclusion, our comparative analysis sheds light on the innovation gap between Singapore and Hong Kong, highlighting their existing disparities in human capital, R&D, and economic connectivity. By implementing strategic policy measures and adopting a forward-looking approach, both cities can unleash their full potential and contribute to sustainable innovation growth in the region and beyond.

References

1. Altinok, N., Angrist, N. and Patrinos, H. A. (2018). Global data set on education quality (1965-2015). *World Bank Policy Research Working Paper,* (8314).

2. Beh, S. (2005). *Singapore — The Biopolis of Asia. Asia-pacific Biotech News*. 09. 10.1142/S0219030305002120.

3. Bilbao-Osorio, B., & Rodríguez-Pose, A. (2004). From R&D to innovation and economic growth in the EU. *Growth and Change*, *35*(4), 434-455.

4. Cai, J., Li, N., & Santacreu, A. M. (2022). Knowledge diffusion, trade, and innovation across countries and sectors. *American Economic Journal: Macroeconomics*, *14*(1), 104-45.

5. Choi, B. (2020). *Four selected measures of the corporate tax burden in Hong Kong and other advanced economies.* https://www.hkeconomy.gov.hk/en/pdf/el/el-2020-02.pdf

6. Cinnirella, F., & Streb, J. (2017). The role of human capital and innovation in economic development: evidence from post-Malthusian Prussia. *Journal of economic growth, 22*, 193-227.

7. Coelli, F., Moxnes, A., & Ulltveit-Moe, K. H. (2022). Better, faster, stronger: Global innovation and trade liberalisation. *The Review of Economics and Statistics*, *104*(2), 205-216.

8. Diebolt, C., & Hippe, R. (2019). The long-run impact of human capital on innovation and economic development in the regions of Europe. *Applied Economics, 51*(5), 542-563.

9. Furman, J. L., & Hayes, R. (2004). Catching up or standing still?: National innovative productivity among 'follower' countries, 1978–1999. *Research Policy*, *33*(9), 1329-1354.

10. Furman, J. L., Porter, M. E., & Stern, S. (2002). The determinants of national innovative capacity. *Research Policy*, *31*(6), 899-933.

11. Girma, S., Gong, Y., & Görg, H. (2008). Foreign Direct Investment, Access to Finance, and Innovation Activity in Chinese Enterprises. *The World Bank Economic Review, 22*(2), 367–382. https://doi.org/10.1093/wber/lhn009

12. Goodstadt, L. F. (2005). *Uneasy partners: The conflict between public interest and private profit in Hong Kong (Vol. 1)*. Hong Kong University Press.

13. Hu, M. C., & Mathews, J. A. (2008). China's national innovative capacity. *Research Policy*, *37*(9), 1465-1479.

14. IPOS. (2021). *Intellectual Property Statistics*. https://www.ipos.gov.sg/resources/statistics

15. Mairesse, J., & Mohnen, P. (2004). The importance of R&D for innovation: a reassessment using French survey data. *The Journal of Technology Transfer, 30*(1-2), 183-197.

16. Marceau, J. (2008). Introduction. *Innovation, 10*(2–3), 136–145. https://doi.org/10.5172/impp.453.10.2-3.136

17. Rosenberg, N., & Nelson, R. R. (1994). American universities and technical advance in industry. *Research Policy*, *23*(3), 323-348.

18. Schneider, P. H. (2005). International trade, economic growth and intellectual property rights: A panel data study of developed and developing countries. *Journal of Development Economics*, *78*(2), 529-547.

19. Siu-kai, L., & Hsin-chi, K. (1990). Public attitude toward laissez faire in Hong Kong. *Asian Survey, 30*(8), 766-781.

20. Sun, X., Li, H., & Ghosal, V. (2020). Firm-level human capital and innovation: Evidence from China. *China Economic Review*, *59*, 101388.

21. Wang, J. (2018). A Tale of Two Cities: Innovation in Singapore and Hong Kong. *Innovation in the Asia Pacific: From Manufacturing to the Knowledge Economy*, 101-117.

22. World Bank. (2020). The Human Capital Index 2020 Update: Human Capital in the Time of COVID-19. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/34432 License: CC BY 3.0 IGO.

23. Young, A. (1992). A tale of two cities: factor accumulation and technical change in Hong Kong and Singapore. *NBER Macroeconomics Annual*, pp. 7, 13–54.

24. Zhu, Y., Mao, K., & Zhang, X. (2020). Innovative Cities Comparison: An Analytical Framework. *ACI Working Paper Series*.